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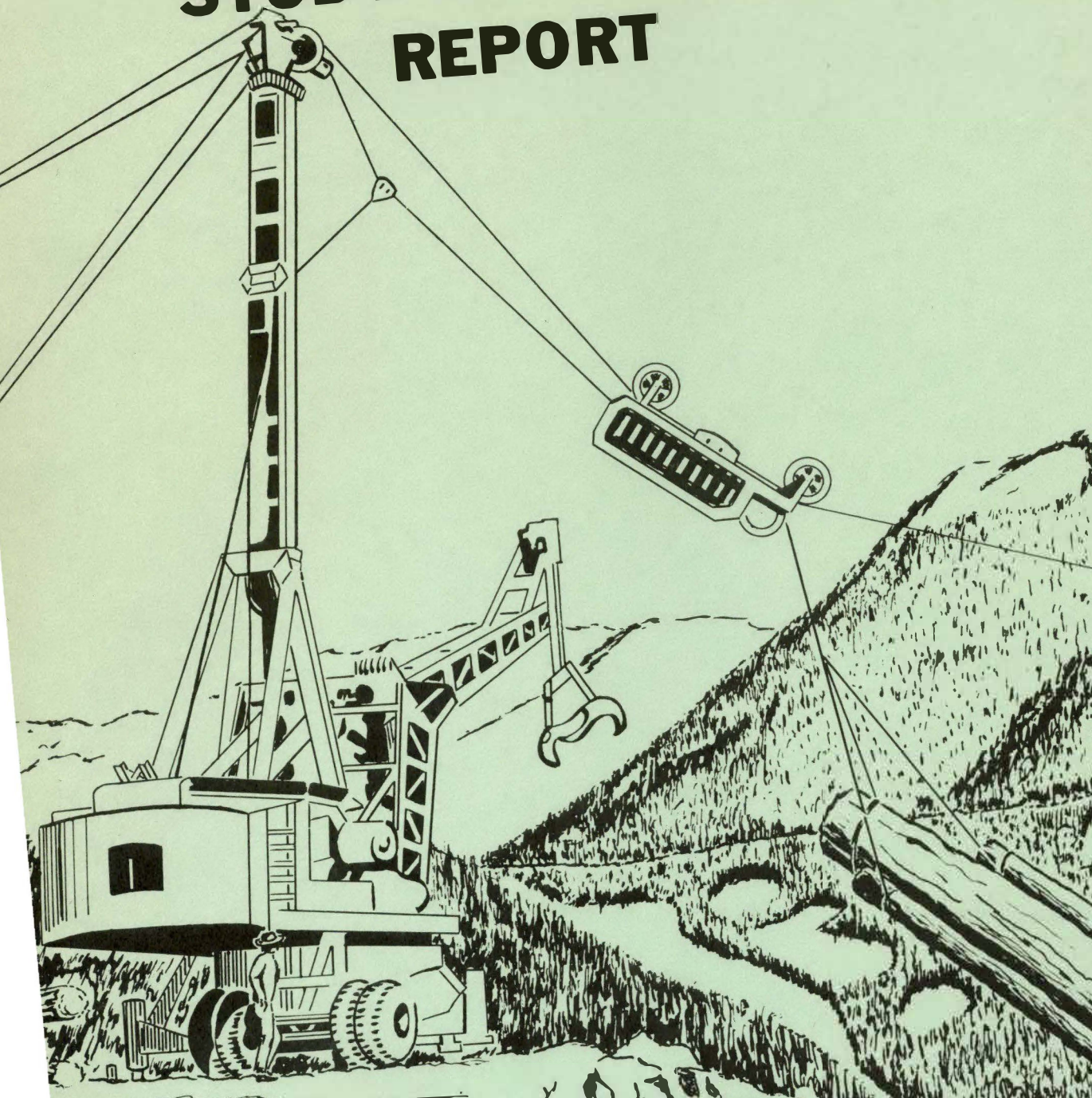
# ZENA CREEK LOGGING

# STUDY EVALUATION REPORT



U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
INTERMOUNTAIN REGION
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

# ZENA CREEK LOGGING STUDY EVALUATION REPORT

Prepared For

The Zena Creek Logging Study

Supervisory Committee

By

George W. Craddock

Ogden, Utah

1967

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# INTRODUCTION

The Zena Creek Logging Study was initiated by the Forest Service in 1958 in an effort to find a satisfactory method of harvesting sawtimber on the steeply sloping lands of the Idaho Batholith having shallow, coarse-textured soil derived from granite. Logging by tractor and jammer skidding methods had been found to be reasonably satisfactory on the more gently sloping portions of those lands in the Boise River and Payette River watersheds. However, as logging operations were extended to steeper lands in those basins and into the Salmon River watershed, the feasibility of harvesting timber by the tractor and jammer systems became highly questionable.

Several deficiencies of these systems became obvious when they were applied on slopes steeper than 50 percent. Tractors could not operate safely. Jammers could skid logs only about 300 feet uphill and 100 feet downhill, leaving numerous skid trails. Moreover, for the jammers to operate, it was necessary to construct from five to nine miles of road per square mile. Some slopes required as many as seven contour roads across their face.

The steeper lands could not withstand such disturbance, and greatly accelerated erosion was set in motion on many sale areas. Landslips were started on slopes above road cuts. Numerous road failures occurred, especially on the incurve fills across drainage depressions, and many of the steeper drainage channels were scoured to bedrock.

In addition to the on-site damage, vastly increased quantities of sediment have been and probably will continue to be contributed to streams draining the upset areas. Important fish spawning reaches were spoiled by sandy bedload deposits, and the stepped up discharges of suspended sediment inevitably will be trapped in downstream reservoirs, channels, and harbors, and thus diminish their usefulness.

Alarmed over these foreseeable consequences, criteria were developed in 1950 for classifying commercial timberlands having slopes in excess of 65 percent, cliffy outcrops, and low volume, as being unloggable. Application of these criteria in the Southwest Idaho Timber Management Study (1) revealed that 26 percent of the area and 22 percent of the commercial timber volume on the Boise, Payette, and part of the Sawtooth National Forests should not be logged. This unloggable volume represented a stumpage income of $750,000 annually, and an annual wholesale lumber products value of $5\frac{1}{2}$ million dollars, if it could be harvested. This analysis pointed up the economic importance of finding a satisfactory system of harvesting the steep slope timber resource.

In 1955, a small timber sale was made to the Brown Tie and Lumber Company of McCall, Idaho, in the lower portion of the Zena Creek watershed on the Krassel Ranger District of the Payette National Forest. In 1957, after operating with tractors and jammers, the purchaser tried a newly designed LeTourneau mobile spar for logging some of the steeper slopes. This machine proved to be too tall, heavy, cumbersome, and costly to operate. However, it was able to yard logs twice as far and with less

soil disturbance and residual stand damage than the jammers. The partial success of this trial suggested that a more efficient mobile spar or an aerial crane, which would require fewer roads, should provide at least part of the solution to the steep slope logging problem.

The Lower Zena Creek Sale area was visited in 1957 by the following group: Ira J. Mason, Division of Timber Management of the Chief's Office; Lester Moncrief, Division of Timber Management, and Arval Anderson, Regional Engineer of Region 4; and Sam Defler, Forest Supervisor, Mark Johanensen, Timber Management Assistant, and Richard Stemple, District Ranger, Krassel Ranger District of the Payette National Forest.

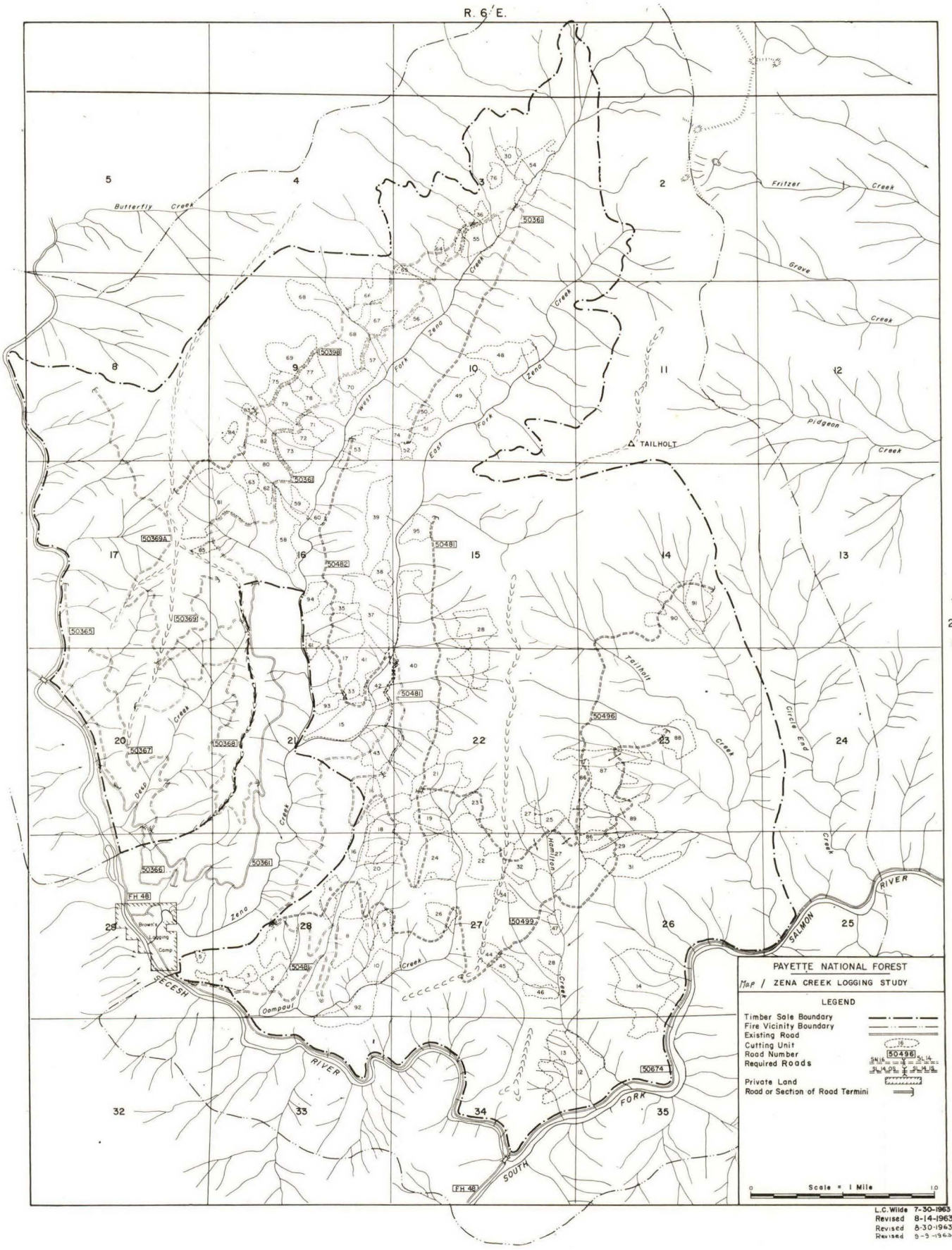
This group agreed it would be highly desirable to undertake a more comprehensive logging study that would include tests of mobile spar and aerial crane equipment. It was also agreed that the remainder of the Zena Creek watershed and the adjacent drainages of Deep, Oompaul, Hamilton, Tailholt, and Circle End Creeks would be suitable for this purpose.

This area subsequently was designated as the Zena Creek Logging Study Area (Map 1). It is located between the confluence of the Secesh River and South Fork of Salmon River, about 34 miles east of McCall, Idaho, via the Lake Fork-Lick Creek road. The study area originally included about 14,900 acres of mountainous lands typical of much of the Idaho Batholith, on which an estimated 60 million board feet of commercial sawtimber was available for a logging operation.

Joel Frykman, who later replaced Moncrief as Assistant Regional Forester in charge of Timber Management, was assigned the task of working with Payette personnel in developing plans for the proposed Zena Creek Logging Study.

After much preliminary planning, an overall study evolved by the fall of 1959, which included three groups of coordinated effort. One was an Administrative Use Timber Sale which provided for harvesting sawtimber on designated cutting units over a 5-year period by newly developed mobile spar and aerial crane equipment, as well as by conventional jammer and tractor skidding methods. A second phase was an Administrative Study program which included several kinds of resource surveys and numerous studies on the cost and effects of virtually all of the Timber Sale operations and treatments. A third phase was a supplemental program of Research Studies on selected aspects of watershed management, tree planting, time-cost relations of log yarding and loading, and road engineering.

Action began on all three phases of the study in 1959 and continued into 1966. During this period, the study required cooperation by the Timber Sale purchaser and his organization, and a wide variety of professional work by numerous Forest Service units. The latter included the Chief's Office; several divisions of the R-4 Regional Forester's Office; the Payette National Forest Supervisor and his staff; the Krassel District Ranger and his staff, including the full time of a Sale Forester; and three divisions and four research projects of the Intermountain Forest and Range Experiment Station.


R. 6 E.
T. 20 N.
Butterfly Creek
Fritzer Creek
Grave Creek
Pidgeon Creek
West Fork Zena Creek
East Fork Zena Creek
Zena Creek
Trailbolt Creek
Circle End Creek
Hamilton Creek
Deep Creek
Oompoul Creek
TAILHOLT
SALMON RIVER
SECESH RIVER
SOUTH FORK
FH 48
Brown's Lapping Camp
50361
50398
50369A
50482
50481
50496
50365
50369
50367
50368
50366
50499
50674
50483
PAYETTE NATIONAL FOREST
Map / ZENA CREEK LOGGING STUDY
LEGEND
Timber Sale Boundary
Fire Vicinity Boundary
Existing Road
Cutting Unit
Road Number
Required Roads
Private Land
Road or Section of Road Termini
Scale = 1 Mile
L.C. Wilde 7-30-1963
Revised 8-14-1963
Revised 8-30-1963
Revised 9-9-1963

After the preliminary planning effort, responsibility for directing and coordinating this complex undertaking was assigned to a 12-man Zena Creek Logging Study Committee which included representatives from Region 4, the Payette National Forest, and the Intermountain Station. This committee met annually in Ogden and on the Study Area to review progress and approve current plans. Numerous changes were authorized during the course of the study as experience brought out weaknesses as well as new facts and promising new procedures, methods, and treatments.

During the October 6, 1965, Zena Creek Logging Study Committee meeting, it was decided to close out the administrative sale contract with logging of areas that were already roaded. This deleted construction of the Model Mile and any roads into Tailholt drainage. Approximately $4\frac{1}{2}$ MMBF of timber on Tailholt and tributary to the Model Mile also was deleted. The contract was terminated by mutual agreement of the purchaser and the Forest Service.

With the Timber Sale nearing completion, the ZCLS Committee, in May of 1966, authorized a chronological review of all of the Study activities from their inception to December 31, 1965, and the preparation of a report which would summarize accomplishments and evaluate the progress made toward meeting the study objectives. Because several separate, though related, kinds of effort were involved, this report has been sectionalized to cover the phases of planning, timber sale operations, administrative studies, research studies, and an evaluation summary.

Appreciation is extended to the many people who provided records, reports, comments, and other help in preparing this report.

## PLANNING FOR THE STUDY

Much planning was done between 1957 and 1960, under the direction of Joel L. Frykman of Timber Management, R-4, to develop action programs for the Zena Creek Logging Study. One phase of the planning effort was on the development and award of a Timber Sale Contract. Several tentative programs of Administrative and Research studies were also developed as adjuncts to the timber sale. Definitive plans for most of the studies were not completed until logging operations started. However, by 1960, agreement had been reached on the objective of most of the studies, and on the responsibilities of the timber sale operator and of Administration and Station units in carrying them out.

### Payette National Forest Proposal, 1958

The first proposal for undertaking the Zena Creek Logging Study was submitted to the Regional Forester by Supervisor Defler on August 18, 1958 (2). This plan proposed a timber sale in the study area of sufficient size and duration which would permit the purchaser to furnish, test, and amortize the cost of specially designed logging equipment. The plan included a justification for such a sale. It also included cost estimates for numerous sale preparation tasks, with suggested responsibilities and timing for carrying them out. Study aspects were not mentioned.

As a followup to this proposal, new aerial photos were obtained, and a mosaic map was made of the study area. The mosaic map was used by the District Ranger to locate a tentative road system, to cruise the timber, and establish tentative cutting units. Other information was obtained with assistance from the Supervisor's staff, for preparation of a timber appraisal and a tentative Timber Sale Contract.

This material was reviewed by R-4 Timber Management and Engineering. The proposed road system was located by stereoplanigraph and checked in part on the ground, with some minor changes resulting. Some changes also were made in the other sale material submitted by the Forest, but with little rechecking on the ground.

### Region 4 Proposal, 1958

A preliminary plan for the study, based on the material submitted by the Forest, was developed by Mr. Frykman. This proposal was transmitted on December 17, 1958, to the Chief's Office for approval (3).

The objective of the proposal was stated as follows:

> To offer a timber sale that will require use of logging equipment to remove normal sawlog-size timber from steep mountainous terrain with construction of moderate road mileage (5 to 7 miles per section) and with minor soil damage.

The sale was to provide for removing from 40 to 60 million board feet of timber over a 5-year period. Logging was to be accomplished on designated areas mainly by a mobile spar which was to be developed for the sale, but also by jammer and tractor skidding. Logging by the Wyssen aerial crane system would be permitted, but only to a limited extent. The plan proposed that the purchaser would furnish the new equipment, and would keep detailed time, cost, and production records on the different logging methods used.

The project was to be supervised by the Forest Supervisor of the Payette National Forest, with technical guidance and assistance as needed from the Division of Timber Management, Region 4. It was also intended, if finances permitted, that the Intermountain Station would participate in making the following tests:

1. Before and after studies, designed to determine the water yields and soil losses.

2. Tests of the effect of road construction on water content in the ground.

3. Silvicultural studies to determine effect on regeneration and residual stands from the three methods of cutting; i.e., jammer skidding, mobile spar, and aerial crane.

4. Methods of cutting.

5. Study of the effectiveness and efficiency of the various types of equipment used.

6. Effect on incidence of insect attack on residual timber related to logging or road construction.

The Chief, by memorandum of January 18, 1959 (4), approved going forward with the study. However, he suggested further consideration be given to several aspects of the timber sale. He also commented on the need for careful planning to obtain all the information desired, and expressed the assumption that the Intermountain Station would be called upon for advice and assistance in the layout of the study.

Review Draft Plan, 1959

The next planning effort was development of a new review draft plan (5). This plan also was developed under Mr. Frykman's guidance. It included essentially the same introductory material as was in the Regional Forester's proposal to the Chief, but included a revised objective and more detail regarding participation and proposed study programs.

The revised objective was:

> To investigate the economic feasibility of logging steep mountainous terrain, consistent with the protection of soil and water values, in keeping with sound resource management.

Proposed participation was enlarged to include the following:

1. Administration, including the Payette National Forest and the Region 4 Divisions of Timber Management, Engineering, and Water, Recreation, and Lands.

2. Research, including Intermountain Station's Divisions of Watershed Management, Forest Management, Forest Disease, Forest Insects, and Forest Utilization, and the Research Center at Boise, Idaho.

3. The timber sale operator.

4. Equipment manufacturers.

The plan proposed that Administrative efforts would be concerned mainly with preparation, award, and management of the sale. However, it was also proposed that the Division of Water, Recreation, and Lands would make a soil survey of the study area, and would finance construction of four stream gaging stations if they were needed by Research. It was also proposed that Administration would undertake other studies if they could not be carried out by the Station.

The plan outlined proposed research study programs for the Station's Division of Watershed Management, Forest Management, and Forest Utilization. Previously suggested programs for the Research Divisions of Forest Insects or Forest Disease were omitted from this plan.

The proposed watershed management research program was intended to determine "what happens to a watershed when it is logged." The following activities and measurements were proposed:

Before and after logging:

1. Continuous streamflow measurements (yearlong).

2. Periodic suspended sediment measurements.

3. Periodic bedload measurements.

4. Snow courses, to be established and measurements made.

5. Establish precipitation gage networks.

6. Soil temperature measurements periodically.

7. Effects of road construction on soil moisture levels.

8. Soil bulk densities, porosity, and textural composition of selected soil types.

9. Extent of bared areas now present.

After logging:

10. Areal extent of soil disturbance caused by different types of logging equipment.

11. Effects of logging on soil temperatures.

12. Effects of soil disturbance caused by logging on natural regeneration.

The proposed program of forest management research was intended:

To compare and evaluate the silvicultural results of logging ponderosa pine and some mixed stands by methods believed suitable to steep mountainous terrain.

The following studies were to be made on areas representative of each method of logging used:

1. Volume per acre before and after logging.

2. Evaluation of logging effects in the residual stand.

3. Stocking and density before and after logging.

4. Stand classification (condition class) and age class distribution before and after logging.

5. Extent and cost of regeneration effort required after logging.

6. Extent and cost of TSI effort required after logging.

7. Success of regenerative effort as measured 3 years after logging.

Two efforts were proposed for forest utilization research. These were:

(1) Provide precisely measured cost control data for the various cable logging systems, and (2) establish close liaison with logging equipment manufacturers.

The last section of the plan included an itemization of responsibilities for all proposed participating units on a "can do" and "would like to do" basis.

A tentative draft of the above plan was discussed in a meeting at the Boise N.F. office on February 3 and 4, 1959. The meeting was attended by representatives of the Payette N.F., the Region Office Divisions of TM and WR&L, and the Intermountain Station Divisions of WMR, FUR, and the Boise Research Center. Mr. Frykman served as Chairman of the meeting.

The objective of the meeting, as stated in a memorandum concerning arrangements and agenda (6), was:

> To reach agreement as to the specific projects Research and the Division of WR&L can conduct, define the objectives of the study, set tentative target dates for the sale offering and initiation of financing needs, designation of responsibilities, and development of plan details as far as time will permit.

The review draft plan, described above, was assembled at the meeting. Agreement was reached on going ahead with preparation for the timber sale. Decisions on the scope of participation by the Station and Administration on the proposed studies were deferred pending further review by the Regional Forester and Director.

A subsequent meeting was held in Ogden. This was attended by representatives of the Payette N.F., the Regional Office, the Station, and by Regional Forester Floyd Iverson and Station Director Reed W. Bailey. Decisions were reached at that time as to which of the "can do" and "would like to do" tasks the Station could perform.

Timber Sale Contract, 1959

In the fall of 1959, the Payette N.F. prepared the Zena Creek Logging Study sale prospectus (7). The introduction of this document included the following:

> ...It is a sale designed to encourage the introduction, development, and use of logging systems and methods which are better suited for logging in steep and very erosible timberland than those presently in use. It is planned that modifications of mobile spar, aerial crane or other cable systems will be the primary systems employed. However, conventional crawler type tractor and jammer logging will be used in certain areas for comparison purposes. The primary objective of the sale is to develop a system of logging that can be used to log areas presently considered nonloggable under present logging methods in use in this area. This system must be such that watershed values are not damaged to any appreciable degree, that relatively low volumes per acre can be handled, and that the system is economically feasible for use in steep terrain.

A Timber Sale Contract was prepared, advertised, and awarded to the Brown Tie and Lumber Company of McCall, Idaho, on October 14, 1959, by Acting Regional Forester Joel L. Frykman (8). The sale was made as an Administrative Use contract under National Forest Regulation S-25. It provided for removal of approximately 60,000 M feet b.m. of sawtimber over a 5-year period. The estimated volumes by species and rates were as follows:

| | Sawtimber - MBM | | | | |
|---|---|---|---|---|---|
| | Live and Recently Dead (Sound Sapwood) | | | | Older Dead (Unsound Sapwood) |
| | PP | DF-WL | WF-AF | ES-LP | All Species |
| Estimated volume* | 31,300 | 21,800 | 5,500 | 1,400 | Unestimated |
| Appraised stumpage | $0.50 | $0.50 | $0.50 | $0.50 | none |
| Stumpage base rate | $0.50 | $0.50 | $0.50 | $0.75 | $1.00 |
| K-V | $3.15 | $3.15 | $3.15 | $3.15 | none |
| Slash disposal | $2.60 | $2.60 | $2.60 | $2.60 | none |
| Erosion control (optional) | $0.20 | $0.20 | $0.20 | $0.20 | $0.20 |

*Sold on a "more or less" basis

In addition to the usual timber sale conditions, the contract included the following special provisions:

1. The operator was to furnish and use at least one specially designed high lead cable system and aerial crane on designated cutting areas, to log other designated areas by jammer, and some others by a combination of jammer and tractor skidding. The logging system requirements were defined more specifically in Section 2g of the contract as follows:

> With the exception of those areas designated for tractor or jammer skidding, the purchaser agrees that all timber designated for cutting shall be logged by a mobile spar or aerial crane or comparable method furnished by the purchaser at no expense to the Forest Service; provided, that not in excess of 1,000 acres shall be logged by an aerial crane method unless logging additional acreage by such method is agreed to in advance by the Forest Service.

The latter provision subsequently was interpreted by the purchaser that "not in excess of 1,000 acres" could be as few as no acres. On this basis, he refused to include the Wyssen type aerial crane system in the study.

2. The operator was to obtain and make available time and cost records of each logging system used.

3. The operator was to construct approximately 75 miles of road. Under Section 2b of the contract the allowable estimated cost of the roads was $939,671.78, or approximately $12,500 per mile.

4. Provision was also included for modifying the terms and scope of the sale, if deemed necessary for purposes of the study, or if the

operation proved to be unprofitable to the purchaser. This was an unusual feature of the sale in that either party to the contract could terminate it without damage to either party.

Administrative Study Plan, 1960

Concurrently with preparation and award of the sale contract, District Ranger H. W. Bonnett developed an Administrative Study Plan for the Zena Creek Logging Study sale. The plan was developed from material in the Review Draft Plan referred to above, and from "numerous memorandums and meetings related to the project." It was approved by D. F. Marsolek, Acting Forest Supervisor, on May 20, 1960, and by A. R. Standing, Acting Regional Forester, on May 11, 1961 (9).

The stated purpose of the plan remained unchanged from that of the review draft plan. However, it included significant changes in the scope of the study and in participation and responsibility. It also included new details concerning the Administrative studies.

The plan proposed that the study be divided into two parts:

1. Studies and observations covering the entire Zena Creek operation to evaluate:

    a. Economic feasibility of logging systems for these types of terrain and timber conditions.

    b. Effects of the tested logging systems on soil and water resources and other land management activities.

    c. Silvicultural aspects of damage to residual stands, cutting area layout, applied silvicultural treatment, and regeneration problems as related to logging systems used, and soil types existing within the study area.

    d. Effects of road construction spacing, standards, locations, and overall system planning on erosion potential, together with the effects of logging methods on these road factors.

    e. Basic soil types and depths and influence on land management decisions and techniques.

2. More detailed study on: Tailholt drainage, using the "best" of the logging methods developed on the Zena Creek sale, to obtain qualitative and quantitative data to evaluate more fully logging influences on streamflow, sedimentation characteristics, and applied silvicultural treatments.

The plan referred to a Memorandum of Understanding between National Forest Administration and Intermountain Forest and Range Experiment Station concerning participation and responsibilities for the study. Though this Memorandum had not yet been consummated, it was stated that:

> In general, the Station will conduct the basic research and observational studies in the fields of watershed management, forest utilization, and forest management.
>
> The Region will be responsible for the administration of the timber sale contract. . .and the coordination of the timber sale operation, with various studies being conducted... In addition, the Region will make a soil survey, construct the stream gaging station on Tailholt drainage, and conduct various administrative cost and time studies which will supplement but not duplicate the studies conducted by the Station.

The Administrative studies were to include the following:

1. Logging costs. Purchaser records will be maintained, and these will be analyzed for appraisal purposes and to determine general economic feasibility, as may be necessary under the timber sale contract.

2. Log hauling costs.

3. Road construction costs.

4. Slash treatment techniques.

5. Road stabilization measures.

6. Regeneration techniques, including use of equipment.

7. Erosion control measures and techniques.

8. Wildlife use, before and after logging.

The plan further specified that:

> The District Ranger, Krassel Ranger District, will be directly in charge of the sale. He will be responsible for coordinating logging operations with the conduct of planned studies. He will be assisted by the District sale officer and temporary personnel as needed.

The plan included a budget covering estimated annual costs of the study. Section VI of the plan gave a brief listing of the methods to be followed in each of the 1 to 8 Administrative studies. Section VII specified that the District Ranger would prepare a detailed annual report on all phases of the study, and that he and the operator would prepare an annual logging plan. Both reports were to be submitted for review by the Zena Creek Logging Study Committee.

Memorandum of Understanding, 1960

The Director and representatives of the Intermountain Station were informed of the Region's intention to undertake the Zena Creek Logging Study during the early stages of planning, and were invited to

participate. As the scope of the proposed study expanded, the amount of Station participation became increasingly questionable. The Station funds and manpower were already committed. Moreover, opportunities for conducting basic research and valid tests were limited by the planned harvest cutting units and road system on the study area. Notwithstanding these limitations, the Station agreed to carry out some supplementary studies, and Director Reed W. Bailey and Regional Forester Floyd Iverson approved a Memorandum of Understanding to this effect in July 1960 (10).

This document recognized the mutual interest of the Station and Region in the Zena Creek Logging Study and confirmed the same purpose or overall objective as was given in the 1960 Administrative Study Plan. It elaborated somewhat on the nature of the study as follows:

> Studies and observations to be carried out in connection with the Zena Creek Logging Sale will be in two general parts as follows:
>
> a. Studies and observations over the entire Zena Creek Logging operation to evaluate (1) production economics of the logging systems used, (2) the effects of the systems on soil and water resources, and (3) the silvicultural implication of the system.
>
> b. A more detailed study on Tailholt drainage using the "best" of the logging methods developed on the Zena Creek Sale to evaluate logging influences on streamflow, sedimentation characteristics, and silviculture. The study will require calibration of Tailholt Creek for a period of years while the Zena Creek Logging operation is in progress, and operation for a period of years following the Tailholt Creek logging.
>
> c. A study of a nonlogged drainage to compare with the Tailholt drainage. The contract to be modified to permit use of the Circle End drainage for this purpose.

Responsibilities were more fully defined than in the 1960 Study Plan as follows:

> In carrying out the general observations and studies over the entire Zena Creek Logging Area and the more detailed studies on the Tailholt and Circle End drainages, the Region and Station will assume responsibilities and make assignments as listed below:
>
> a. The Region
>
> 1. Assume full responsibility for administering the Zena Creek Sale to the Brown Tie and Lumber Company to provide tests of two or more different cable logging systems on steep terrain.

2. The normal line of administrative authority will be respected in dealing with the Brown Tie and Lumber Company. The Regional Forester's representative will be the Supervisor of the Payette National Forest, who will be represented on the sale area by the District Ranger on the Krassel District or his designated representative.

3. Make a soil survey of the Zena Creek Sale Area.

4. Construct a stream gaging station on Tailholt drainage.

5. Cooperate with the Station and the U. S. Geological Survey in operating the Tailholt stream gaging station.

6. Cooperate with the Station in preparing study plans for the general Zena Creek study and the Tailholt and Circle End study.

7. Provide the Station with copies of logging cost records which the contract requires the purchaser to keep and all other important documents concerning the sale including logging layout maps, timber estimates, timber sale prospectus, timber sale contracts including modifications, cutting and logging plans, progress maps, or any other material that may be necessary for the conduct of the studies planned by the Station.

8. Cooperate in preparation of final reports of Zena Creek general study and the Tailholt and Circle End study.

9. Be responsible for, in cooperation with the Station, all publicity concerning the Zena Creek Sale and studies.

b. The Station

1. The Station, through its research divisions, will undertake specific research studies in the Zena Creek Sale Area as outlined briefly under "Nature of the Study" above.

2. Prepare study plans for the general Zena Creek Sale studies.

3. Prepare study plans for the Tailholt and Circle End Creek studies.

4. Carry out the plans listed under 2 and 3 above, except for responsibilities that may be assumed by the Region as a result of formal agreements that may be reached later.

5. Prepare reports of the Zena Creek Sale Study and the Tailholt and Circle End Study in cooperation with the Region.

The Memorandum of Understanding also established a Committee to give general supervision to the study. The Committee was to be made up from representatives of the following units:

Payette National Forest
- Forest Supervisor
- District Ranger

Regional Office
- Division of Timber Management (Chairman of Committee)
- Division of Watershed and Multiple Use
- Division of Engineering
- Division of Wildlife Management

Intermountain Station
- Boise Projects in Watershed and Forest Management Research
- Division of Watershed Management Research
- Division of Forest Utilization Research
- Division of Forest Management Research
- Division of Engineering Research

The Committee was directed to operate as follows:

> This Committee will meet at least once a year, preferably before February 15, to review progress of the Study and develop logging plans for the ensuing year which will best accomplish the purpose of the studies within the framework of the Sale contract. Logging plans for the ensuing year will not become effective until reviewed and approved by the Committee.

Except for the detailed planning on the Timber Sale, planning on the study phases up to the time of awarding the Timber Sale Contract had been highly general. Most of the problems had been recognized, but no critical analysis was made of each of the problems as a basis for developing sound study plans. As a consequence, many of the study activities as well as the timber sale operations ran into difficulties which required followup corrective action by the Supervisory Committee.

ZCLS Supervisory Committee

The task of directing the study after the start of logging operations was assigned to the following members of the Zena Creek Logging Study Committee:

Chairman: Joel L. Frykman, Division of Timber Management, R-4

Members: A. R. Croft, Division of Watershed and Multiple Use, R-4
J. M. Usher, Division of Engineering, R-4
F. C. Noel, Division of Wildlife Management, R-4
Sam Defler, Forest Supervisor, Payette N.F.
Howbert Bonnett, District Ranger, Krassel R.D., Payette N.F.
Dr. O. L. Copeland, Division of Watershed Management Research, INT
C. A. Wellner, Division of Forest Management Research, INT
E. S. Kotok, Division of Forest Utilization Research, INT
H. M. Huckeby, Forest Engineering Research Project, INT, Bozeman, Montana
J. D. Curtis, Ponderosa Pine Silviculture Research Project, INT, Boise, Idaho
H. F. Haupt, Soil Stabilization Research Project, INT, Boise, Idaho

Because of transfers or retirement, the following replacements were made on the ZCLS Committee during the course of the study:

E. L. Noble for A. R. Croft, retired in 1962
Edwin A. Heikkenen for Bonnett, transferred in 1962
Dr. Nedavia Bethlahmy for Haupt, transferred in 1963
Rulon Gardner for Huckeby, retired in 1964
S. Blair Hutchison for Kotok, transferred in 1965
Marlin C. Galbraith for Frykman, retired in 1966.

The Supervisory Committee met annually in Ogden. It also met annually at the Secesh Project Camp, and made inspections of the Study Area, as listed below:

| | |
|---|---|
| February 14, 1961 | at Ogden, Utah |
| May 16-17, 1961 | at Secesh Project Camp |
| February 13, 1962 | at Ogden, Utah |
| May 15-16, 1962 | at Secesh Project Camp |
| February 14-15, 1963 | at Ogden, Utah |
| May 1963 | at Secesh Project Camp |
| December 6, 1963 | at Ogden, Utah (subcommittee on Model Road) |
| March 5, 1964 | at Ogden, Utah |
| May 1964 | at Secesh Project Camp |
| September 1964 | at Secesh Project Camp |
| February 1965 | at Ogden, Utah |
| May 1965 | at Secesh Project Camp |

These sessions resulted in a number of changes in the operation of the timber sale, and in the scope of both Administrative and Research studies. These changes were authorized as experience during the course of the study brought out weaknesses that needed rectifying and promising new facts, ideas, methods, and treatments.

One factor which influenced the course of the study was information obtained from a soil survey. The survey was begun in the summer of 1959

and completed in 1960 by the Soils Section of the R-4 Division of Water, Recreation, and Lands (11).

Section I of the Soil Survey Report provided generalized descriptions and capabilities of 10 soil mapping units made up of single soil taxonomic units and six mapping units made up of two intermingled soil taxonomic units. Section II presented some suitability interpretations concerning ponderosa pine production and erosion hazard appraisals. Section III presented detailed soil mapping unit descriptions. The locations of the soil mapping units were shown on a soils map.

This information was not used in planning the initial road system or harvest cutting units. However, as road failures occurred and difficulties developed over harvesting operation and regeneration planting, the soil survey data provided an important basis for modifying the road system, eliminating some low volume stands from the sale, and selecting more promising sites for planting.

Concurrently with completion of the Soil Survey on the Study Area, Region 4 developed a multiple use management guide for the Southwest Idaho Subregion (12). This guide brought out the susceptibility of steep granitic soils to accelerated erosion. It encouraged a fresh look at the potential hazards on the Zena Creek Logging Study Area, and lent support for making major revisions of the road system and in the cutting units remaining to be harvested.

Some sporadic climatic events occurred during the course of the study. These sharpened appreciation of the damaging potential of storms in the Idaho Batholith.

The first of these events occurred during the period October 7-14, 1962, when from about 7.5 to nearly 10.0 inches of rain fell on the area. Though of relatively low intensity, the volume was sufficient to saturate the soil mantle. Surface runoff and erosion was moderate on most of the area, but many sections of road, especially fill slopes, were washed out or were badly eroded (Photos 1 and 2). The disastrous results of this storm triggered action to reduce the planned road network, and to forego harvest cutting on parts of the sale area.

Two other storm events occurred during the winter of 1964-65. These were described by Jensen and Cole (13) as follows:

> During the first period, December 21, 1964, to about mid-January, 6.83 inches of precipitation fell mostly in the form of rain. Snow on the exposed slopes (containing 3 to 6 inches of water) was melted by these conditions, and contributed more moisture to the soils. Slide damage occurred on most of the exposed slopes.
>
> During the second period, April 19 to 22, 1965, snow melting was at its peak, and 1.52 inches of rain fell. Serious mass soil movement occurred on steep slopes traversed by roads at an elevational zone of approximately 5,500 feet.

Photo 1. Part of material eroded from an upper road fill during 1962 storm.

Photo 2. Large section of fill eroded from road shown in upper photo.

The further watershed damage from these storm events reemphasized the vulnerability of the steeply sloping granitic lands, and the need for a more critical look at road construction and logging disturbances in relation to hydrologic and strength characteristics of the soil. The Committee authorized such a survey in 1965.

Numerous other technical changes were made during the course of the study in the operation of the timber sale, and in the conduct of the administrative and research studies.

## TIMBER SALE OPERATIONS, 1959-65

One of the major phases of the Zena Creek Logging Study was operation of the timber sale. This involved operational planning and reporting, the construction of a road system, and the harvesting of timber by different logging methods.

### Annual Operating Plans

The sale operations were carried out in accordance with annual operating plans prepared by the District Ranger and the purchaser, which were reviewed and approved by the supervisory committee. Six plans were prepared covering each of the operating seasons of 1960 through 1965 (14). Each plan covered the following features:

Sale data, specifying the company, contract number, sale unit, and sale expiration date.

General, specifying the starting date, estimated volume to be cut, daily volume to log, and other information concerning company and Forest Service representatives.

Road construction, specifying the equipment and crew to be used, and the designation of road sections to be constructed to given standards.

Logging, including a cutting plan, and specifications concerning types of equipment, methods, and number of men to be used in falling, skidding, and loading.

Scaling, specifying location and methods.

Erosion control, describing work to be done by the purchaser and the Forest Service.

Slash disposal, specifying Forest Service and purchaser responsibilities.

Fire protection, as specified in a separate fire plan.

Safety, covering measures developed jointly by the Forest Service and the purchaser.

Special records, including special time and cost records to be obtained by the purchaser concerning the different logging methods used.

### Annual Progress Reports

Annual reports were made by the District Ranger following the close of seasonal activities. Seven of these progress reports were prepared, starting with the 1959 season (15). The format of these reports varied from year to year. However, all included brief descriptions on various aspects of the sale operations, and on the progress of both administrative

and research studies. A summary report was also made covering these activities from 1962 through 1965 (16). A number of separate reports also were made on phases of the Administrative and Research study programs, which are referred to in the last two sections of this report.

Road Construction

It was originally estimated that approximately 75 miles of road would be required to harvest the timber on the sale area. The system was to include 18.25 miles of primary road to SN-16' standards, and 56.63 miles of secondary roads to SN-14' standards. However, only about 40 percent of this amount was constructed (Map 2).

The sequence and amount of actual road construction was as follows:

| Year | Mileage |
|---|---|
| 1959 | 3.00 |
| 1960 | 7.60 |
| 1961 | 2.40 |
| 1962 | 9.09 |
| 1963 | 4.00 |
| 1964 | 3.15 |
| 1965 | Negligible |
| Total | 29.24 |

Major factors contibuting to the shrinkage of the originally planned road system were revision of the Timber Sale Contract in 1963 (17) and the previously mentioned 1965 decision to close the contract. These revisions eliminated the Circle End and Tailholt Creek watersheds from the sale area for research calibration purposes, also some low volume and vulnerable riverbreak areas to curtail further watershed damage. These changes reduced the sale area from 14,895 acres to 9,146 acres, and the sale volume from 60,000 M to 39,977 M. They also reduced the mileage of system roads from 74.88 to 34.43, but increased the mileage of spur roads from 4.0 to 9.3.

Another factor was the demonstrated capacity of the mobile spar and skyline crane to yard logs over greater distances than was anticipated. This permitted a wider spacing and relocation of some roads which eliminated the need for some, and thus resulted in a further reduction in road mileage.

A third factor was the tremendous road damage which occurred during the heavy rains of October 1962. Though only about 20 miles of road had been constructed up to that time, many sections in the Deep Creek and Oompaul Creek drainages were badly damaged. The greatest damage occurred to fills across drainage channels, but there was also extensive slumping of other fill and cut slopes, as well as erosion of the road bed (Photos 3 and 4).

There were several reasons for the road failures. Inadequate ground checks resulted in locating some sections on slopes that were too steep.


R. 6 E.
T. 20 N.
TAILHOLT
50361
50398
50359A
50359
50365
50482
50481
50368
50367
50366
50361
50496
50674
50485
FH 48
West Fork Zena Creek
East Fork Zena Creek
Zena Creek
Tailholt Creek
Circle End Creek
Hamilton Creek
Deep Creek
Dampgul Creek
SECESH RIVER
SALMON RIVER
SOUTH FORK
MAP 2. PLANNED & CONSTRUCTED ROADS
ZENA CREEK LOGGING STUDY AREA
PAYETTE NATIONAL FOREST
LEGEND
Planned Roads
Constructed Roads
Road System No. 50482
Timber Sale Boundary
Scale = 1 Mile
0
1.0

The operator was permitted to use 14-foot wide bulldozer blades and cast excavated material on downslopes steeper than the angle of repose for that material, and to leave roughed out roads without adequately providing for drainage or stabilization. If drainage structures had been installed in the fall of 1962, the resulting damage would have been considerably less as evidenced by other areas with properly installed drainage. Some of these errors stemmed from too little understanding of the capacity of the granitic soil and rock mantle to withstand road construction disturbance, but some could have been prevented by more alert and forceful supervision.

The enormity of watershed damage caused by the road system did not fully come to light until further slumping and erosion occurred during the "Christmas" storm of 1964, and the "rain-on-snow" storm during the spring of 1965.

A survey of the sources and extent of flood damages in the study area and other nearby watersheds from these storms was made in the spring and summer of 1965. The survey covered undisturbed areas, a burned area, and areas which had been roaded and logged in recent years. In discussing their findings (13), Jensen and Cole stated:

> The December-January damage, with the exception of road cut slumps and most of it on the Poverty Burn, was unpreventable. The undisturbed areas affected were naturally very unstable and show signs of recent similar damage. We feel that the April damage and much of the Poverty Flat burn damage could have been prevented or greatly reduced had the deep soil disturbances on these areas been avoided. More specifically, we feel that had road construction and contour terracing on these steep slopes not been done, the damage would have been much less on the Poverty Flat burn, and nearly lacking on the areas damaged in April.

The recommendations in this report were as follows:

1. Any land disturbing activity on slopes over 45 percent on the granite soils of the South Fork of the Salmon drainage should be preceded by hydrologic reconnaissance.

2. When constructing new roads on this area, on slopes under 45 percent, lay fill and waste material at a 50-percent (2:1) slope.

3. Fill slopes on new roads constructed on this area, on slopes over 45 percent, should be artificially supported. Cut slopes above culvert inlets and in other critical areas should also be artificially stabilized, where solid rock is not present.

4. Select clearcutting areas located on slopes over 45 percent with care. Avoid cutting on shallow soil sites and sites undercut by roads.

Photo 3. Slumping caused by road cut slope during 1965 storms. The undercut upper slope will probably continue to unravel to the ridge top.

Photo 4. Road fill section in Deep Creek washed out during 1965 storm.

5. Do not contour trench future burned areas in the decomposed granite soils on the South Fork drainage. Instead, seed with a perennial grass mixture, and remove debris from natural stream channel so the increased runoff can be discharged in a more natural manner. If roads traverse the watershed, open up all drainage channels on temporary roads and adequately increase culvert size and frequency on permanent roads to handle the increased runoff.

6. Encourage and support studies by fishery experts to determine effective methods of fishery habitat protection and rehabilitation.

7. Protect the Poverty Burn area from any new disturbances.

8. Work toward better control of road drainage water, on existing permanent roads on steep slopes in the drainage, by surfacing with gravel or asphalt and placement of drainage structures in most of the intercepted microdrainages.

9. On existing roads in Deep Creek drainage, open all water channels crossed by roads to keep water in its natural channels.

10. Remove debris from Cow Creek and reroute the water into its natural channel to prevent "ponding up" and massive stream channel erosion in the future.

The effects of the road system in the study area were more critically examined in 1966 (18). The road system was found to be the dominant source of sediment production. It was estimated that this system had produced 129,000 cubic yards of eroded material between 1960 and 1966, of which 50,000 cubic yards was from slumping during the spring of 1965. Present rates of road erosion were estimated at about 16,000 cubic yards per year, 99 percent of which was from roads constructed on decomposed granitic lands.

It was also estimated that 25,000 cubic yards of eroded material had already been discharged into the Secesh River, and that present sediment discharges are at a rate of 3,440 cubic yards per year. This is 10 times the natural rate of sediment production for the study area as a whole. In the Zena Creek watershed, where less than half of the area has been logged or contains any roads, the current sedimentation rate is now 20 times normal. In the Deep Creek watershed, in which a complete road system had been constructed and was heavily logged, it was estimated that sediment production in 1965 was 1,000 times normal.

These findings led to the following recommendations concerning future roadbuilding in the Batholith area:

5. Construct roads in a "normal manner" only on strongly glaciated lands.

6. Modify roadbuilding practices on peri-glacial land to account for their weaker qualities.

7. Modify roadbuilding practices, when possible, on river terrace land to avoid cutting the face of the terrace.

8. Limit roadbuilding on stream-cut, decomposed granitic lands to ridge tops, unless total cut and fill stabilization can be accomplished as a part of construction and the intercepted subsurface flow can be discharged without disrupting the hydrology.

9. Design all engineering structures to accommodate a 5" rain storm in a 4-day period and/or a 1.5" storm in a 6-day period.

11. Investigate a "ridgetop only" or a "no road" system of harvesting timber from the area.

12. Put-to-bed all roads possible on decomposed granitic lands.

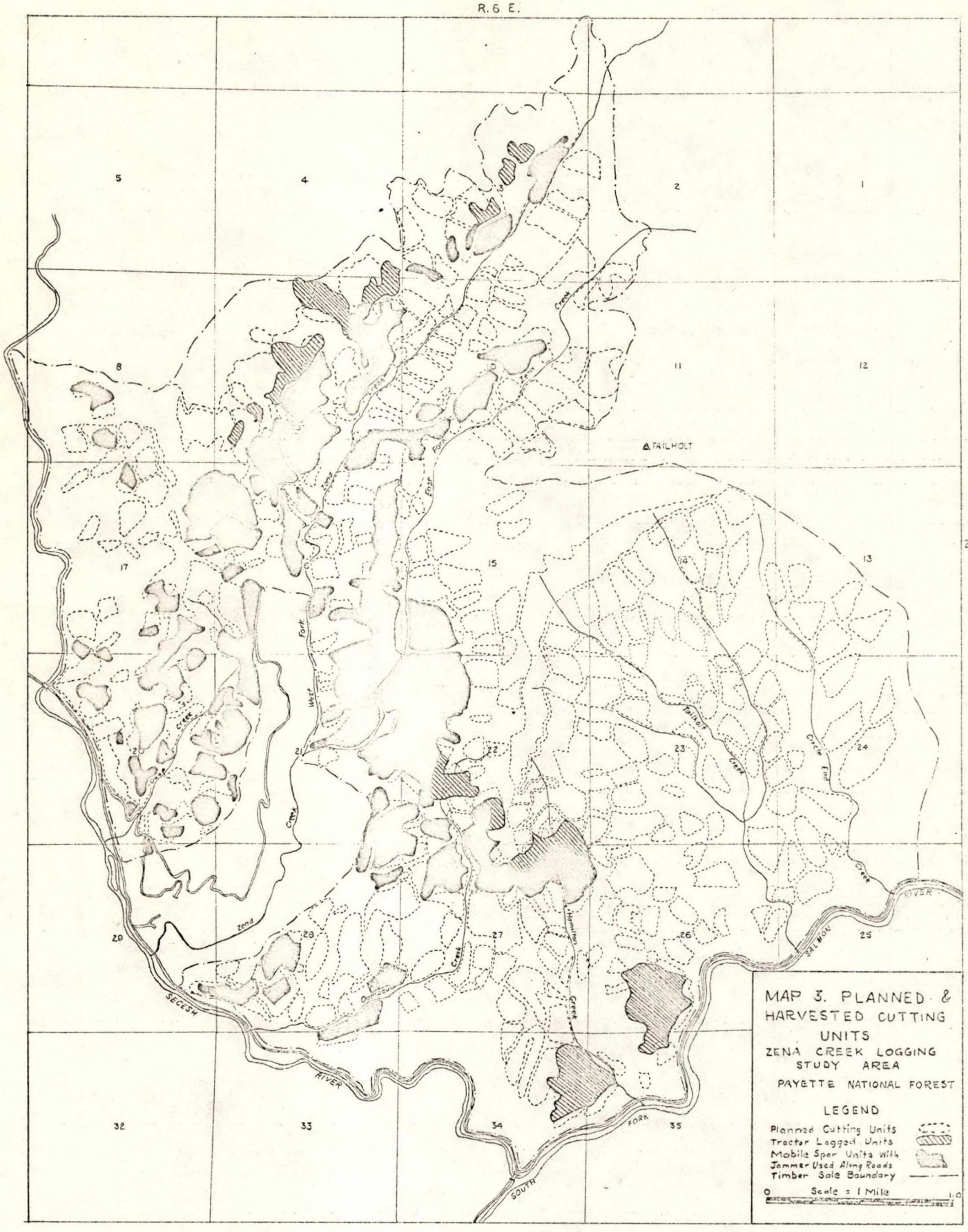
There was tremendous damage caused by the road system. However, many lessons were learned about where and how not to build roads. The recommendations in the reports cited should prove helpful in the planning and construction of future roads in the Idaho Batholith.

Harvest Operations

Timber harvesting began on a small scale late in the fall of 1959, as soon as the first roads were constructed to provide access to the sale area. Harvesting progressed at more rapid rates in succeeding years until 1966, by which time a total of 33.2 million board feet had been removed from the sale area, as shown below:

| Year | Harvested (MBF) |
|---|---|
| 1959 | 737 |
| 1960 | 1,371 |
| 1961 | 4,053 |
| 1962 | 4,368 |
| 1963 | 5,070 |
| 1964 | 3,027 |
| 1965 | 11,059 |
| 1966 | 3,515 |
| Total | 33,200 |

The total harvested volume was only about 54 percent of the 60 million board feet contracted for in the original sale. However, as mentioned previously, the sale contract was substantially modified in 1963 (17) to exclude part of the sale area and much of the previously considered merchantable volume (Map 3).


R. 6 E.
T. 20 N.
TAILHOLT
Zena Creek
West Fork
East Fork
Tailholt Creek
Hennings Creek
Orofino Creek
SECESH RIVER
SALMON RIVER
SOUTH FORK
MAP 3. PLANNED & HARVESTED CUTTING UNITS
ZENA CREEK LOGGING STUDY AREA
PAYETTE NATIONAL FOREST
LEGEND
Planned Cutting Units
Tractor Logged Units
Mobile Spar Units with Jammer Used Along Roads
Timber Sale Boundary
Scale = 1 Mile

Though reduced in size, the sale provided an opportunity to try two types of mobile spar-aerial crane logging equipment as well as tractors and jammers.

In 1959, logging started on November 9 and stopped on December 24. One area was logged by jammer, and another by tractor skidding.

In 1960, the purchaser brought in a Skagit SJ-7R mobile logger. This equipment included a mobile logger equipped as a grapple loader and self-propelled tower (Photo 5), and a Skagit Model RCC-10 Radio Controlled Sky Car which operated as an aerial crane (Photo 6).

This unit was designed for logging in stands of about 10 M board feet, and to be moved from set to set in 30 minutes. Maximum production with a 5-man crew was expected to be from 40 to 50 MBF daily. Its efficient yarding distance was supposed to be 700 to 800 feet, with a maximum of 1,200 feet, and a side skid range of 150 feet.

The full capacity of this unit was never attained, except for brief periods, because of technical and operational deficiencies. The spar tower buckled because of insufficient guy supports. The radio controls did not always function in controlling the sky car, and the unit was damaged from time to time by collision with trees, stumps, and rocks. Use of the mobile spar for loading required cessation of yarding with the sky car, thus causing delays. General inexperience with the new equipment and labor troubles also contributed to less production than anticipated.

The use of this equipment for downhill logging proved to be unsatisfactory principally because of difficulty in controlling the descent of logs, but also because of ground disturbance and damage to the residual stand. Uphill logging proved to be more satisfactory, especially after it was learned to set the aerial crane cable at a great enough height so logs could be lifted above ground and carried to the loading deck without ground or cover disturbance.

In 1964, the Timber Sale Contract with Brown Tie and Lumber Company was transferred to the Boise Cascade Lumber Corporation by a third party agreement (19). However, under this arrangement the Brown Tie and Lumber Company continued the logging operations.

In 1964, an improved type of Skagit mobile spar was added to the logging operation (Photo 7). This equipment had an improved tower which operated a radio controlled sky car similar to that used with the Skagit SJ-7R. It was not equipped with a grapple loader. This unit proved to be more maintenance free. It could yard for distances up to 1,800 feet, and do so faster than the SJ-7R.

The use of the Skagit mobile yarder was supplemented by mobile jammers which skidded logs close to the roads, by tractors which skidded on ridges and gently sloping areas, and by mobile loaders (Photo 8). This combination approached the desired production of 50 MBF per day, and did so with an acceptable small amount of ground disturbance and residual stand damage.

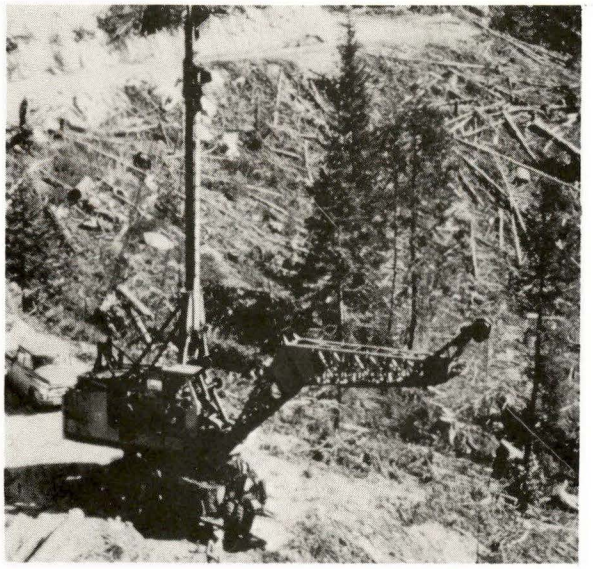


**Photo 5.** **Skagit SJ-7R mobile logger equipped with spar tower and grapple loader.**

**Photo 6.** Skagit Model RCC-10 Radio Controlled Sky Car With a turn of logs enroute to loading deck.

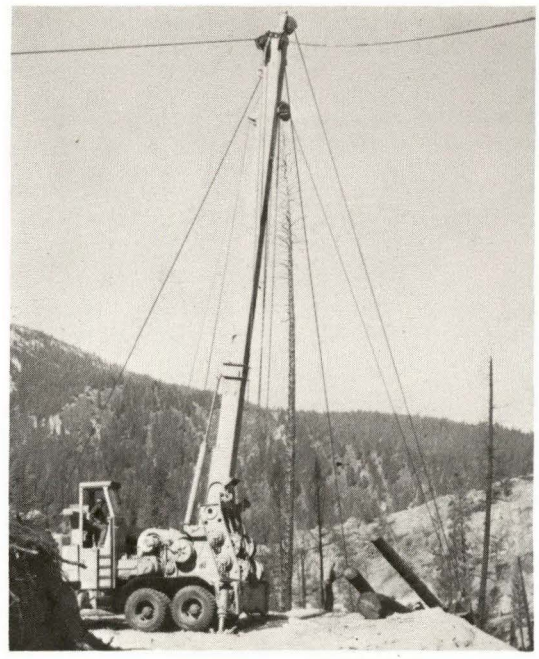


Photo 7. The improved Skagit Mobile Spar Yarder.

Photo 8. The Skagit Mobile Yarder operating with a separate, mobile jammer for loading on the Poverty Burn.

It was originally intended that a Wyssen type aerial crane system would also be used in the study, at least to a limited extent, in the hope that such a system would permit aerial yarding for distances up to a mile of slope distance, and thus further reduce the amount of road construction. However, the contract provisions concerning logging systems were not explicit enough to force the purchaser to use a Wyssen type system.

The mobile spar and aerial crane system clearly was an improvement over the conventional tractor and jammer systems, mainly because fewer roads were required but also because of less residual stand damage and ground disturbance.

## ADMINISTRATIVE STUDIES

The 1960 Administrative Study Plan proposed a program of eight studies concerning phases of the timber harvesting operations and of past logging operations in the Zena Creek Logging Study area. Detailed plans for the individual studies were not available for review. However, accomplishments on each study were briefly reported in the annual progress reports previously referred to (15). Separate reports were also prepared on some of the studies. In addition to the efforts on the eight studies, a plan was proposed for studying a model road, a survey was made of flood damages in 1965, and an overall condition survey was proposed for 1966.

### Logging Costs

This was a cooperative study between the District Ranger and timber sale purchaser, to obtain skidding and loading costs on each of the timber sale cutting units as affected by different methods of cutting and logging systems.

A Skagit SJ-7R Logging Costs Administrative Study Report No. 6 summarized two sets of skidding and loading costs obtained in 1960 (20). These included: (a) costs while skidding with the SJ-7R mobile spar and sky car; and (b) costs while the SJ-7R was used for jammer skidding above the road. These costs were reported as follows:

| Cost Group | Units Logged | Volume Logged | Skid Cost/M | Load Cost/M | Total Cost/M |
|---|---|---|---|---|---|
| A | 8, 9, 10, 11 | 417.96 M | 12.50 | 3.28 | 15.78 |
| B | 12A, 12B | 63.63 M | 13.61 | 2.50 | 16.11 |
| | | 481.59 M | 12.65 | 3.17 | 15.82 |

A similar report (21) summarized the skidding and loading costs for four groups of cutting units during the 1961 season. The average skidding and loading costs for these four groups were given as follows:

| Logging Methods | Number Cutting Units | MBF Volume Logged | Skid Cost/M | Load Cost/M | Total Cost/M |
|---|---|---|---|---|---|
| SJ-7R + Sky Car | 12 | 1,443.54 | 14.12 | 4.63 | 18.75 |
| Same + Tractor | 3 | 730.81 | 9.78 | 3.19 | 12.97 |
| Tractor | 2 | 269.53 | 5.13 | 1.32 | 6.45 |
| SJ-7R as Jammer | 4 | 366.90 | 8.26 | 3.38 | 11.64 |
| Average all | | | 9.32 | 3.13 | 12.54 |

Records of skidding and loading costs in 1963 were summarized for two groups of cutting units (22). Group A consisted of Douglas-fir, white fir, and Engelmann spruce stands averaging less than 20" d.b.h., from which 812.21 M was removed by the Skagit SJ-7R mobile spar and sky car. Group B included three cutting units of ponderosa pine at low elevations, from which 341.82 M was logged with the same equipment. Average costs were reported as follows:

| Cutting Group | Skid Cost/M | Load Cost/M | Breakdown Cost/M | Total Cost/M |
|---|---|---|---|---|
| A | 11.04 | 4.02 | 1.28 | 16.34 |
| B | 12.56 | 4.57 | 1.46 | 18.59 |

The accuracy of the records obtained from the purchaser in 1960, 1961, and 1963 was questioned by the Sale Officer and District Ranger.

The 1965 Skagit Yarder Logging Costs Report (23) covered operations on 10 cutting units, totaling 161 acres of mixed ponderosa pine and Douglas-fir, from which 2,790 MBF of timber was removed. About 80 percent of the logging was done with the Skagit mobile spar and sky car. The remainder was done by a heel boomjammer. The jammer also was used for loading. Good records were obtained on several aspects of the operation.

The cost of felling and bucking 10,268 logs was determined to be $3.79/MBM, as shown below:

| | |
|---|---|
| Total number of logs | 10,268 |
| Average piece size | .252 MBF |
| Total volume felled | 2,588 MBF |
| Total cost | $9,811.00 |
| Cost/MBF | $3.79 |

Yarder production with the Skagit mobile spar and sky car required 12 major and 25 minor sets, and 1918 man hours. The hours were broken down as follows: 1435.5 production time; 316.5 production down time not due to mechanical failure; and 168.0 machine down time, 98 percent of which was due to breakdown and repair of the sky car. The costs of yarding with this equipment were summarized as follows:

| | |
|---|---|
| Number of logs skidded | 8,967 |
| Volume skidded | 2,259 MBF |
| Total cost | $47,639.00 |
| Cost/MBF | $21.09 |

Jammer skidding was accomplsihed between units on a high-risk method of cutting. Generally, skidding distances were limited to 200 feet below and 100 feet above roads. These costs were summarized as follows:

| | |
|---|---|
| Number of logs skidded | 2,102 |
| Volume | 530 MBF |
| Cost/MBF | $8.00 |

The jammer loading costs for both types of yarding averaged $2.82, as itemized below:

| | |
|---|---|
| Number of pieces loaded | 11,069 |
| Volume, MBF | 2,790 |
| Total cost | $7,878 |
| Cost/MBF | $2.82 |

These 1965 data show that the stump-to-truck cost of logging, exclusive of road construction, averaged $27.70/M for logs yarded by the Skagit mobile spar and sky car, and $14.61/M for those yarded by jammer. Since about 80 percent of the volume was yarded by the Skagit mobile spar and sky car, the average cost of the combined operations was about $25.00/M. This is about twice the $12.19/M estimated cost for this phase of the operation in the original 1959 appraisal. However, the higher cost derived from the study appears to be realistic considering the volume and topography involved, and provided a sounder basis for redetermining the stumpage rates and development road allowances covering the final stages of the timber sale.

Hauling Costs

The purpose of this study was to determine the time and cost of hauling logs from the sale area to the mill at McCall, Idaho. The study was based on records supplied by the contractor and information concerning the roads traversed from the Forest Service. The study was reported in the Skagit Yarder Logging Costs Report for 1965 (23).

The haul road characteristics were described as follows:

Hauling distances (miles) were: Min. 36.4, max. 40.4, and aver. 38.4. Haul was over 16.0 miles of adverse grade, averaging 3.95 percent, with maximum grade of 13.3 percent. There were 24.4 miles of favorable grade, averaging 3.31 percent.

Road standards and surfacing were described as follows:

2.9 miles of 24' - 2 lane, paved surface
31.1 miles of SM16, dirt surface
6.4 miles of SL14, dirt surface

Load characteristics were reported as follows:

| | |
|---|---|
| Average number of pieces per load | 22.8 |
| Average volume per load | 5.750 MBF |
| Total number of loads | 485 |
| Average number of loads per day | 9 |
| Average number of loads per truck | 2.25 |
| Average round trip time | 6 hours |

Hauling costs were summarized as follows:

| | |
|---|---|
| Total number of logs hauled | 11,069 |
| Average piece size | .252 MBF |
| Total volume hauled | 2,790 MBF |
| Total cost of haul | $34,611.00 |
| Cost/MBF | $ 12.40 |
| Average cost/load | $ 71.30 |

The hauling costs in 1965 were about $3.00/M greater than was originally estimated. The greater cost for this phase of the operation was also

considered in redetermination of rates for the final portion of the sale.

Road Construction Costs

The purpose of this study was stated in Engineering Study Report No. 1 as follows:

> ...to gather information that will provide a basis for (1) better cost estimates of actual purchaser road construction on required system and temporary work roads; (2) identification and segregation of costs that have already been included in general logging costs under overhead, general supervision and camp expenses; and (3) adjustment of annual road cost experience in the region for preparing cost estimate guides. It is also desirable to determine the feasibility of developing roads in this area due to the steepness of slopes, high erosive character of the soils, and damage to the watershed.

The first report of this study (24) was based on analysis of costs for construction 7.6 miles of road in 1959 and 1960. The engineering estimate of the direct and indirect construction cost was $104,294.80, or about $13,723 per mile. Company records showed the actual cost to be $114,482, or $15,063 per mile.

A second report covered costs of constructing roads in 1961 (25). Three units were reported on as follows:

> Unit 1 (Secesh Deep Creek) 0.5 mile, total cost per mile $9,962.23
> Unit 2 (Zena Creek) 1.22 miles, total cost per mile $18,752.01
> Unit 3 (Oompaul-Hamilton) 0.17 mile, total cost per mile $12,358.94

The $9,962 per mile cost for the 0.5 mile of work road was considered excessive because $2,098 was charged against it for supervision during a period when no construction was underway. A more realistic cost for this type of road was given as $5,764 per mile.

The $18,752 cost per mile of primary SN-16 road was considered higher than normal because of adverse weather conditions during construction, a large amount of required blasting, and steepness of side slopes.

The $12,359 per mile cost for constructing 0.17 miles of SN-16 road was considered to be of questionable value because of the short section of road involved.

Both reports referred to included statements that additional cost records were to be obtained in subsequent years. Unless they were, it appears that this study did not provide as much cost information as was intended. However, through related observations and experience during the course of the road cost study much was learned about location, design, and

supervision phases of road construction. This information was helpful in the later stages of the study and should be of great value in planning future roads in the Idaho Batholith.

Hazard Reduction Techniques

The purpose of this study was:

> To determine methods of hazard reduction most suited to the various conditions found in the study area, and the methods most satisfactory to all phases of resource management.

The study was to be made by the Payette N.F. and the Regional Office Division of TM. Several methods of brush disposal were tried during the course of the study, including piling by hand, by tractor, lopping and scattering, and burning. These trials were briefly reported in the Annual Progress Reports for 1960 to 1965, inclusive (15). From these reports, the sequence of effort appears to have been as follows:

In 1960 and 1961, a very limited amount of brush disposal work was done. This included mostly lopping and scattering, and some spot burning.

In 1962, some piling was done by machine and hand. A 16-acre clearcut was broadcast burned. A chipper was also tried along the upper side of primary and secondary roads.

In 1963, a 60-acre clearcut was broadcast burned.

In 1964, the Annual Report indicated 33 acres of clearcut were hand piled and burned at per-acre costs of from $53 to $74. Preparation work for broadcast burning was being contracted at from $12 to $14 per acre, and the burning operation costs were estimated at from $12 to $15 per acre. Tractor piling was also completed on 24 acres, at a cost of about $23 per acre.

During 1965, 20 acres were broadcast burned and 30 acres were machine piled with a John Deere tractor equipped with a brush blade.

In a summary discussion of the study in the 1966 General Administrative Report (16), it was stated that:

> The cost of brush disposal was estimated at $2.00/MBM for piling, $1.50/MBM for lopping and scattering, and $0.50/MBM for burning. Based on these estimates, $2.60/MBM was allowed in the Zena Creek Logging Study contract for brush disposal. This converts to a cost per acre of $33.80, based on an average of 13 MBM per acre.

This summary also proposed the following "Priorities:"

1. Complete disposal (broadcast burning, jackpot burning, hand piling) in clearcut units with high potential fire hazard.

2. Complete disposal (jackpot burning, hand piling) on both sides of system roads for distances 100' above and 200' below roads.

3. Partial disposal (lopping and scattering)in release units of high slash concentration. (Release units with low volume of slash were to have no treatment.)

Road Stabilization Measures

This study was to determine the cost and desirability of different techniques for stabilizing cut and fill slopes and for controlling water beyond the road prism. The study was to be made by the Payette National Forest and the Regional Office of TM, E, and W&MU. The study included several tests.

A test of grass seeding for stabilizing road fills was initiated in 1960 (26). The test involved five treatments: seeding, dragging, fertilizing, mulching, and netting. These were applied singly and in various combinations on 11 fill areas on Road 917.1 and on 7 fills on Road 917H. Actual costs ranged from $1.64 to $16.74 per 1,000 square feet of treated area, depending on treatment. The range of predicted cost for a larger-scale operation was from $0.97 to $12.78 per 1,000 square feet.

A second test of grass seeding for stabilizing fill slopes was initiated in 1962 (27). This test was made on 10 acres of fill sections along the Zena Creek Road No. 50367, which had been constructed in 1960. Most of the road sections above the treated slopes were outsloped and cross ditched, but some were insloped for carrying water to existing drainage structures. Treatments included seeding, fertilizing, and mulching with straw and asphalt. Average cost of treatment was $285.09 per acre. About 50 percent of the treated area failed because of fill slumping.

In 1960, a test of culvert downspouts and waterspreaders was initiated on Zena Creek Logging Study Road No. 917.1, as an adjunct to the test of grass seeding on fill slopes. This test (28) involved 10 installations. Treatments on most included cutting off excess "cannon" culverts and attaching downspouts. Rock and wire spreaders were installed at the bottom of some downspouts, and a sediment dam was constructed at one location.

Additional installations were made in 1961 at 14 locations (29). These included the same treatments as were applied in 1960, but also included installation of some culverts on previously undrained sections.

The average cost per installation for both years was as follows:

| | |
|---|---|
| Culvert downspouts | $145.39 |
| Waterspreaders | 22.88 |
| Erosion control dams | 26.66 |

No installations of downspouts were made after 1961, because by installing the culverts on natural ground level, the need for culvert downspouts was eliminated.

Another test for stabilizing fill slopes, called the Oompaul Erosion Project, was initiated in 1962. It involved treatments on 15 fills of Road No. 50481 (977). The treatments included one or a combination of two or more of the following: drop inlets to culverts, silt dams below fills, contour trenching, jute netting, and straw mulching, together with fertilizer and seeding of fills, and fiberglass lining of two ditches.

The heavy rains of October 1962 caused severe slumping and gullying on most of the fill slopes treated, as well as on comparable untreated fill slopes. Improper road construction and inadequate attention to drainage contributed to these failures.

Regeneration Techniques

In 1960, two related studies were initiated on regeneration techniques. One was concerned with ponderosa pine direct seeding, and the other was on the effectiveness of site preparation.

The direct seeding study (31) involved planting five seeds on 45 prepared spots on each of five plots. On plots 1, 2, and 3, spots were prepared by scalping. On plot 4, seeds were planted in contour furrows. Plot 5 was located on a skidtrail.

No specific results of this study have been reported.

The site preparation study (32) was initiated on a clearcut area, and involved four preparation treatments. These included construction of contour trenches by a Rotokat and hand preparation of three different sized scalped areas. All planting of 2-0 ponderosa pine stock was done by hand. This study was expanded to include additional test areas and treatments each year.

The 1962 Annual Report (15) indicated 9,500 ponderosa pine seedlings were planted that year, at an average cost of $93.18 per acre. Planting was done on a skidtrail and a burn, in addition to areas prepared by contour trenching and various sized scalps. Firt-year survival was reported as ranging from 40 to 100 percent, and averaging 70 percent.

The 1963 Annual Report (15) indicates an additional planting of 17,000 ponderosa pine and 3,000 Douglas-fir seedlings at an average cost of $94.95 per acre. First-year survival was reported as being 58 percent for Douglas-fir and 78 percent overall.

In 1964, planting was further expanded to include 20,000 ponderosa pine, 18,000 Douglas-fir, and 15,000 Engelmann spruce. Site preparation ranged from broadcast burning to hand scalps. First-year survival was reported as 95 percent for ponderosa pine, 48 percent for Douglas-fir, and 32 percent for Engelmann spruce. The overall average survival for three seasons was 84.5 percent.

In 1965, an additional 26,000 ponderosa pine and 8,000 Engelmann spruce seedlings were planted. The first-season survival was 82 percent for ponderosa pine, and 73 percent for Engelmann spruce.

The results of this study were further summarized in the 1966 General Administrative Report (16). It was concluded that site prepration by Rotokat or powersaw trencher was too difficult and expensive on steep slopes. Regularly spaced hand scalps were also considered unsatisfactory because soil depth was reduced too much, and the system did not permit selection of spots having deeper soils. Burning was considered to be the best site preparation treatment, except on areas of deep duff, which should be scalped to mineral soil.

Erosion Control Measures

This study was intended to determine the cost and effectiveness of different erosion control measures for stabilizing the soil on areas subjected to different systems of cutting and methods of logging. The study was to be carried out by the Payette N.F. and the Regional Office Division of Timber Management and Division of Watershed and Multiple Use.

The files at Ogden do not include any plans or reports of accomplishment concerning this study.

Wildlife Habitat Studies

The 1960 Administrative Study Plan proposed a study of wildlife use before and after logging. The study was to be aimed at three objectives:

1. To determine utilization and population trends of deer and elk before and after logging.

2. To determine effect of logging on abundance and utilization of deer and elk winter forage.

3. To coordinate the findings of wildlife, watershed, and other studies conducted on the area to give full knowledge of factors other than timber harvesting that may affect stream and sediment flow.

In 1961, the Annual Report (15) included the statement:

> Studies set up, so far, include one Parker 3-step cluster and browse-utilization and permanent pellet transects.

The 1962 Annual Report (15) stated that several studies were initiated in 1961:

> Two Parker 3-step transects were established. Four browse utilization and pellet-count transects, two of which are in the intermediate zone and two in the winter range zone were also established. The purpose of these transects is to study the effects of clear cutting of timber on browse production and big game use. Big game range analysis classification and typing was completed on the Hamilton, Tailholt, and Circle End drainages.

The 1963 Annual Report (15) included the following paragraph:

> Browse utilization and pellet-count transects were established in 1963 (kind, number or location not specified). Readings were taken on transects that were established previously. The purpose of these studies is to evaluate the effects of game and clear cutting on browse production and game use. Big game range classification and typing has been completed for the ZCLS area.

The 1964 Annual Report (15) included the following observations:

> The deer and elk herds throughout the South Fork of the Salmon River experienced an unusually hard winter in 1964. Browse utilization on the Zena Creek Logging Study winter range areas showed moderately heavy use throughout Hamilton Bar and Tailholt drainage, and extremely heavy use throughout Circle End and Three-Mile drainages.
>
> Wildlife browsing of plantations has not been a serious problem on the ZCLS area. However, problems are anticipated with increased cutting in the winter range. The first plantation on the winter range will be established in 1965.

The 1965 Annual Report (15) included the following paragraph:

> Previous transects were maintained, and readings indicate a moderate winter use by big game. Utilization approximated 50 percent, with 10 to 3 days use per acre for deer and elk, respectively.

In 1966, a "wildlife compendium" report was prepared by Finn and Heikkenen (33). This report included information on the wildlife resource and use, and the listing of big game management in the ZCLS area and in the South Fork winter big game range area. The report also summarized the specific studies that had been undertaken concerning the big game range analysis, an extensive habitat-type map, and the browse study. The report included the comment that all of the studies are "of a long-term nature, and as yet there is insufficient data for conclusions."

Subsequent observations showed that game use on the upper, summer range portion of the ZCLS area has been very light, with no perceptible damage to watershed values or to tree seedlings. Game use has been a little more concentrated on the lower, winter range portion of the study area. Even here, however, there is but little indication of damage to reproduction or to watershed values.

Model Road

The excessive damage which occurred on many sections of the road system in the Zena Creek Logging Study area through 1962 indicated the need for

further consideration of road location, design, construction methods, and supervision. In 1963, the Zena Creek Model Road Subcommittee was appointed and assigned the task of preparing a plan for development of a model road. The membership of this subcommittee was as follows:

Chairman: Joel L. Frykman, Timber Management, R-4

Members: J. M. Usher, Engineering, R-4
H. Minor Huckeby, Forest Engineering Research Project, INT
E. S. Kotok, Forest Utilization Research, INT
Sam Defler, Forest Supervisor, Payette N.F.
Dr. Otis Copeland, Watershed Management Research, INT
Rulon Gardner replaced Huckeby in 1964.

Two meetings of the subcommittee were held in 1963, and a like number in 1964 and 1965. Some of these preceded or followed meetings of the overall ZCLS Committee.

The first draft of a plan was prepared by Usher and Huckeby on July 29, 1963. This plan was revised at subsequent meetings of the subcommittee under the guidance of Subcommittee Chairman Frykman (34).

The intent, nature, and justification for the study were stated in the objective section of the plan as follows:

> Objective. To construct a section of system logging road demonstrating the best techniques of planning, design, construction, and maintenance to meet predetermined land management criteria. Define land management criteria in terms of economics, erosion, water quality, and safety.
>
> To reach this objective, a road will be located, designed, and constructed on Payette National Forest Road No. 50499 on the Zena Creek Sale area to meet these criteria. This road will be designed to serve the timber accessible to this route and other land uses, as well as to demonstrate acceptable standards that can be used as a guide for construction of other roads in mountainous areas.
>
> To meet the predetermined land management criteria, the road will be engineered as a best fit by varying gradient, width, surface, drainage, and stabilization.
>
> Many miles of road with variable geometrics or standards have been built in the area. Utility has been good, costs high, construction methods and supervision questionable, and end results have been pronounced as outside the limits of acceptability on land disturbance and soil erosion. Presently some roads are characterized by long fill slopes, high cut banks, and what appears from observations to be excess movement and placement of loose soils to meet the design standards. Observation and analysis indicate "over" and "under" design, careless

and unorganized construction methods and inadequate supervision. Road design and construction methods have been too often geared to what purchasers could accomplish with available equipment. Too often, standards and methods are predicated on past practices. Preconstruction studies have not been adequate for location coordinated with logging methods and other predicted use, optimum standards at minimum costs which meet land management objectives (erosion control, esthetics, long-time stability).

The inadequacies noted above indicate clearly that techniques and procedures must be developed which can be applied with understanding to guarantee an accurate prediction of end results.

Twelve road performance criteria were agreed upon as being necessary to meet the basic land management objectives of soil and water protection. The tentative criteria were as follows:

1. Drainage discharge into natural channels will not exceed that volume and rate which will occur from a 50-year storm.

2. During construction and for the 3-year period following, sediment production into the live streams will be no more than the tolerance calculated from the preconstruction hydrologic analysis.

3. Three years after construction, cut and fill slopes, and other land areas altered by construction will be stabilized or contained to their preconstruction hydrology.

4. The basic design speed for the road will be 10 miles per hour.

5. The traffic design will be for (volume), (type), and (frequency).

6. The minimum travel width and the minimum width at spar sets will be _____ and _____.

7. The season of use will be _____.

8. The design for the road drainage should meet the 50-year storm (6-inch storm in 4 years).

9. Fire hazard _____.

10. The design should be for the lowest total cost for transportation.

11. Road surface rivulets will not exceed 1 inch in depth in 5 years.

12. The road will be designed to a maximum adverse gradient of 4 percent, and a maximum pitch of 10 percent for 1,000 feet.

A 1.3-mile section of road was located across the middle portion of the Oompaul watershed. The road was designed as an SL-14-IS; that is, an insloped road, 14 feet wide, with a 4-foot ditch. Special construction features were included to meet the model mile criteria, including full bench cut, drains at all depression crossings, and structural stabilization of both out and fill slopes. The cost was estimated at $122,000 per mile.

A study and analysis of the hydrologic effects of the proposed road was made in 1964 and reported by Megahan on March 1, 1965 (35). This report indicated the proposed road would not meet the hydrologic limits specified in the established criteria.

It was decided not to proceed with construction of the model mile road in the Zena Creek Logging Study area. This decision was based on the high cost of a small section of road which would service very little timber since the adjoining Tailholt drainage had been dropped from the sale. In addition, the presence of an existing road above the proposed model mile road would influence conclusions about the effects of constructing the model mile.

Condition Survey

Late in 1965, Supervisor Defler proposed that a condition survey be made of the Zena Creek Logging Study area. Separate consideration would be given to logging areas, roads, stream channels, game areas, and other areas of disturbance, such as those caused by project fires and insect infestations.

The survey was made in 1966 (18). In this survey and analysis, all of the major activities of the Zena Creek Logging Study were related to five land types having different degrees of stability, strength, and hydrologic capacity. The concepts and analytical procedures used, and the relationships found in this survey should be of great help, if as expertly applied, in planning multiple use management in similar portions of the Idaho Batholith.

## RESEARCH STUDIES

Four programs of research studies were carried out on the study area. These included the functional fields of watershed management forest utilization research, forest management research, and forest engineering research.

### Watershed Management Research

Since 1959, the Soil Stabilization Research Project at Boise has undertaken 10 watershed management research studies having a direct bearing on the Zena Creek Logging Study area. Eight of the studies were carried out in the ZCLS area. One was made on the Boise National Forest, and another was proposed for both the Boise and Payette National Forests.

The program was carried out by H. F. Haupt and W. J. Kidd during the years 1959-63, and by N. Bethlahmy and W. J. Kidd during 1964 and 1965. Cooperative assistance on two studies was obtained from the WMR project at Logan. Assistance, in the form of materials and personnel, was also obtained on several of the studies from the Payette N.F. and from the Regional Office, Division of Watershed Management.

Study plans are on file for all but the first of the studies. Annual reports on accomplishments and plans for the years 1961 through 1965 have been submitted to the ZCLS Committee (36). Semiannual reports for the Division of WMR provide other information on accomplishments for the years 1960 through 1965.

Five reports have been published as Station Research Notes. One has been published as a Master's thesis; two other publications are in review draft form.

### Precipitation Study

Collection of precipitation data on the ZCLS area was begun in 1959 to provide climatic information for all phases of the sale operation and both Administrative and Research study programs. A network of three recording and three standard gages was installed in May of 1959 to record spring, summer, and fall precipitation. In 1960, a standpipe gage was added to the network to provide a record of winter precipitation. In 1962, one gage was relocated, and three storage gages and one yearlong recording gage were added. In 1964, one recording gage was dropped from the network. In 1965 and 1966, the network consisted of six recording gages, including one year-round and four nonrecording storage gages.

Average annual precipitation for the 7-year period, 1959, to 1966 at the 5,000 foot elevation of the study area was about 26 inches. Monthly totals ranged from .01 inch in July of 1966 to 8.54 inches in October 1962 (Table 1).

Early in the study, Kidd assembled high intensity rainfall data from the study area and from records obtained elsewhere on the Boise and

Payette National Forests. His report (37) provided useful information on the amount of precipitation for durations of 5, 10, 15, 20, 25, 30, 35, 40, 60, and 80 minutes. Data were also assembled on the maximum intensities of rainfall during 1-, 2-, 3-, 5-, 7-, 8-, 10-, 15-, and 20-minute periods.

On the basis of 229 recorded rainstorms on the Zena Creek Logging Study area between 1959 and 1963, Kidd also developed a series of useful curves on the probable return periods of rainstorms in Central Idaho, having varied volume, durations, and intensities (38).

Tailholt-Circle End Watershed Evaluation Study

This study was initiated in 1959 to determine the effect of a "best" logging method on streamflow characteristics and sediment production. Logging effects were to be determined by differences in water yields, discharge rates, and sediment loads between a logged and unlogged watershed following a period of calibration. The 1,625-acre Tailholt watershed was selected for subsequent logging, and in 1962 the 800-acre Circle End watershed was selected as the control area.

A stream gaging station was installed on Tailholt Creek in 1959, and a sediment trap was added in 1960. A stream gaging station and sediment trap were installed on Circle End Creek in 1962. Streamflow records have been obtained continuously, and sediment measurements have been taken each spring and fall since the installations were completed.

Maximum instantaneous discharges and bedload sediment yields from Tailholt Creek during 1961, 1962, and one month of 1963, and from Circle End Creek during four months of 1962 and one month of 1963, were reported in the 1962 Progress Report.

The reaction of Tailholt and Circle End Creeks to 47 storm events during the period September 1962 to November 1963 was reported in the 1963 Progress Report. The coefficients of correlation for two variables, the length of time it takes the creeks to peak and the amount of rise in stage, were found to be 0.94 and 0.86, respectively. A further analysis revealed that stage relation between the two creeks during periods of increasing flow can be predicted by the equation:

$$T = 1.042C + 0.700$$

Where T anc C refer to stream stage of Tailholt and Circle End Creeks, respectively.

In the 1965 Progress Report, water yields and sediment production from the two watersheds for two complete water years were reported as follows:

| Water Years | Tailholt Creek | Circle End Creek | Ratios |
|---|---|---|---|
| | Water yields (inches) | | |
| 1962-63 | 13.20 | 7.97 | 1.6/1 |
| 1963-64 | 10.74 | 8.09 | 1.3/1 |
| | Bedload sediment (lbs/sq. mi./day) | | |
| 1962-63 | 130.6 | 71.2 | 1.8/1 |
| 1963-64 | 127.2 | 103.0 | 1.2/1 |

Table 1. Monthly precipitation at 5,000-foot elevation of the Zena Creek Logging Study Area, 1959-1966

| Year | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1959 | -- | -- | -- | -- | 2.01 | 0.81 | 0.24 | 0.84 | 3.86 | -- | -- | -- | -- |
| 1960 | 3.36 | 4.29 | 6.22 | 3.31 | 3.35 | 0.30 | 0.23 | 0.81 | 0.86 | 1.67 | 8.00 | 1.22 | 33.62 |
| 1961 | 3.17 | 3.73 | 3.61 | 2.02 | 2.01 | 0.82 | 0.04 | 0.76 | 0.96 | 2.65 | 2.79 | 3.10 | 25.66 |
| 1962 | 2.18 | 3.15 | 2.47 | 1.59 | 3.47 | 1.24 | 0.67 | 1.06 | 1.26 | 8.54 | 4.10 | 1.75 | 31.48 |
| 1963 | 2.23 | 1.72 | 2.98 | 2.41 | 2.14 | 4.96 | 0.21 | 0.43 | 1.62 | 1.63 | 2.86 | 1.05 | 24.24 |
| 1964 | 3.14 | 0.35 | 2.18 | 1.10 | 1.50 | 4.42 | 0.89 | 1.55 | 0.74 | 0.56 | 2.48 | 5.62 | 24.53 |
| 1965 | 5.42 | 1.11 | 0.19 | 3.40 | 0.97 | 1.69 | 0.84 | 1.85 | 2.09 | 0.78 | 1.84 | 0.67 | 20.85 |
| 1966 | 2.79 | 1.00 | 1.98 | 0.94 | 0.56 | 1.53 | 0.01 | 0.34 | 1.23 | 0.92 | 2.45 | -- | 13.31* |
| Monthly Average: | 3.18 | 2.19 | 2.86 | 2.25 | 2.07 | 2.23 | 0.41 | 0.96 | 1.45 | 2.42 | 3.50 | 2.24 | 25.76 |

*Total exclusive of December 1966.

In 1965, sites were located on each of three headwater tributaries in the Tailholt watershed for installing additional stream gaging stations and sediment traps. Construction of trails to the three sites was started in 1966.

The records from these experimental watersheds are filling a great void concerning the runoff characteristics of small drainage basins in the mountains of southwestern Idaho. They have already provided heretofore missing basic data for hydrologic analysis. Their value for this purpose will increase as additional records are obtained in the years ahead. The paired watersheds in addition will provide a sound basis for evaluating the effects of logging or other treatments on streamflow and sediment production.

Logging Compartment Study

This study was begun in 1960 to determine the effects of jammer and mobile spar-skyline crane logging systems on sediment production. Upper portions of the Deep Creek and Oompaul Creek watersheds were selected for the study. In each of these watersheds, one compartment was designated for jammer logging and another for mobile spar logging. Sediment production records were to be obtained prior to road construction, after road construction, and after logging. Sediment was to be measured behind dams installed on subdrainages of 3 to 15 acres in size and also from 1/100-acre runoff plots. The latter were to be installed on contrasting aspects and on sites having deep and shallow soils.

In 1960, eight sediment dams were constructed in each of the watersheds, and sixteen runoff plots were installed in the Deep Creek watershed. Twelve runoff plots were installed in Oompaul Creek during 1961. The number of dams and plots for each of the proposed treatments in the two watersheds were as follows:

| Watersheds: | Deep Creek | | Oompaul | |
|---|---|---|---|---|
| Treatments: | Jammer | Mobile spar | Jammer | Mobile spar |
| Sediment basins | 3 | 5 | 5 | 3 |
| Runoff plots | 8 | 8 | 6 | 6 |

In the Deep Creek watershed, operations progressed essentially as planned. Two roads were constructed across the jammer compartment in 1961. No additional road was needed in the mobile spar compartment. Both compartments were logged in 1962. Thus, sediment production records were obtained from both dams and plots for about a year before roadbuilding, for another year prior to logging, and twice each year thereafter.

Unfortunately, the roads across the jammer compartment were poorly located and constructed, and adverse weather prevented prompt completion

of stabilization measures. The jammer test was, therefore, a test of the worst way to do the job, and not a test of a good job. The test results show it.

In the lower portion of the Oompaul watershed, none of the proposed operations materialized; that is, no roads were constructed and there has been no logging. There was some minor cutting in the upper reaches of the drainages. Therefore, the dams and plots, thus far, have provided a record of sediment production under near normal or natural conditions.

Partial records of sediment production for various periods have been presented in the watershed management research semiannual reports, and in annual reports to the ZCLS committee. No comprehensive summary or analysis of results to date has been made.

Three years' data from the undisturbed runoff plots in the Oompaul Creek watershed were used as a basis for a proposed 1966 publication: "Natural erosion rates as related to exposure--a study of granitic soils on steep terrain in Idaho," by Nedavia Bethlahmy and W. J. Kidd, Jr.

Road Fill Slope Stabilization Study. This study was initiated in 1962 to test the effectiveness of artificial seeding, a variety of muches, and supplemental watering for establishing plant cover and stabilizing soil on fill slopes of a first-season road. The effectiveness of the treatments was to be measured on 56 runoff plots, 4 x 6 feet in size. The plots were installed and treatments were applied in the summer of 1962 as follows:

No treatment on four plots.
Fifty-two plots were seeded to a grass mixture.
Thirteen different mulches were applied to each of four seeded plots.
Two of each mulched plot were to receive water for one season.
Two of each mulched plot would not be watered.

This study was to include a second objective: to determine physical and chemical changes in the fill soil before and after application of six of the mulch treatments.

In October, one month after the plots had been installed and treated, the study area received unusual heavy rainfall. Runoff during this storm washed out 16 of the plots. The main portion of the study was abandoned, though it was assumed the less-damaged plots may provide future information on plant survival and cover establishment.

The scope of the secondary study was also changed to include spring and fall measurements of soil losses and vegetation production on six differently treated groups of plots, in addition to several physical and chemical analyses of soil samples taken before and one year after the treatments. This phase of the study was reported in 1964 as a M.S. thesis (39). Two summary statements from this report are given below:

> There is no indication from the analysis of the soils data that the slope susceptibility to erosion has been significantly reduced during the treatment year. The trend in the soil properties is toward less severe conditions for plant growth, but the conditions necessary for plant germination, growth, and distribution must still be provided by surface treatment.
>
> ...it appears that one layer of Erosionet is the most effective treatment for promoting slope protection.

A related study of soil stabilizing treatments was undertaken in the fall of 1962 on a fill slope of the Bogus Basin road on the Boise National Forest. Eight 1/100-acre plots were used to test the effect of the following treatments on sediment production:

1. Control - no treatment.
2. Contour furrows, seed, fertilizer, holes.
3. Contour furrows, straw mulch, seed, fertilizer, holes.
4. Polymer emulsion, seed, fertilizer.
5. Straw mulch, paper netting, seed, fertilizer.
6. Straw mulch, jute netting, seed, fertilizer.
7. Seed, fertilizer, straw mulch, chicken wire netting.
8. Seed, fertilizer, straw mulch with asphalt emulsion.

Soil losses were measured six times between December 10, 1962, and October 11, 1963.

In a report on results (40), the average amounts of eroded material from plots receiving three types of treatment were as follows:

| Group Plot Treatments | Eroded Material (1,000 lbs./acre) | Standard Errors |
|---|---|---|
| A - Seed and fertilizer | 97.1 | ± 7.3 |
| B - Seed and fertilizer, plus straw mulch | 24.0 | ±12.0 |
| C - Seed and fertilizer, plus straw mulch, plus netting | 0.5 | ± 0.3 |

The authors commented as follows:

> Obviously, Group C plots had less erosion than plots in the other groups. The netting bound the mulch snugly to the soil, thus minimizing erosion by overland flow.

> Mulching prevented soil splash as a result of raindrop impact. Thus, erosion was checked during the time when the raw slope was most vulnerable, as well as after the grass became established.

Outsloped and Insloped Road Damage Study

Following the heavy rainstorms of October 1962, an observational survey of damage to insloped and outsloped sections of a newly constructed secondary road in the ZCLS area was made by H. F. Haupt, H. C. Rickard, and L. E. Finn. Their findings were summarized (41) as follows:

> Insloping a roadbed under the time, topographic, soil, and storm conditions described is more desirable than outsloping as a measure for preventing erosion and damage to the roads.

Seed Displacement Study. This study was undertaken in 1962 to determine the effects of various treatments for holding seed on steep fill soil material. Four boxes, 2 x 2 feet in size, were filled with mixed, fresh road fill of granitic origin. The boxes were tilted to provide a soil surface of 70 percent. The test involved nine fill slope and seed treatments and two types of seed (hard and rounded, and elongated and flat). The purpose, methods, and results of this study were abstracted in a report (42) as follows:

> Attempts to seed fill slopes of newly constructed roads often fail because seed is not retained on the hardened, compacted, crusted surfaces of the fills. Model "road fill slopes" were set up in the laboratory to test several soil surface treatments for arresting downward movement of broadcast seed.
>
> Results of this study suggest that seeding upon a mulch already in place, "pockmarking" the soil surface, wetting the soil surface, and spreading wetted seed, reduce seed dispersion.

Infiltrometer Study

In July of 1963, an infiltrometer crew from the Soil Stabilization Project at Logan assisted Bethlahmy and Kidd in carrying out a study to determine the effects of two contrasting exposures and of logging and no logging on infiltration rates. The tests were made on 32 plots under the following conditions:

> Eight plots on north slopes, logged.
> Eight plots on north slopes, not logged.
> Eight plots on south slopes, logged.
> Eight plots on south slopes, not logged.

A tentative analysis of these tests, presented in a progress report, indicated that:

> ...high intensity storms induce greater erosion on southwest in contrast to northeast slopes; and that after light logging, as practiced in this steep terrain, high intensity storms may increase erosion on southwest slopes, but do not appear to be detrimental on northeast slopes.

Infiltration rates were also obtained on four road fill plots and four road cut plots. Results of these tests were partially reported in the 1963 Progress Report to the ZCLS Committee. Infiltration values, expressed as percent of applied rainfall, were determined to be as follows:

| Road type | Position on road | |
|---|---|---|
| | Center | Edge |
| Fill | 15.1 | 24.0 |
| Cut | 12.0 | 29.4 |

Soil Moisture Study

This study was undertaken in the summer of 1963 to determine the effect of slope exposure on soil moisture content. Soil moisture was determined for three soil depths on north and south slopes at 3-week intervals from mid-June to mid-September. The average percent moisture content for the season was reported in the WMR Semiannual Report for April-September 1963, as follows:

| Soil Depths (inches) | Exposure | Soil moisture content | | | | | Percent moisture at: | |
|---|---|---|---|---|---|---|---|---|
| | | 6/26 | 7/17 | 8/8 | 8/29 | 9/19 | 1/3 atm. | 15 atm. |
| 0-2 | N | 17.6 | 3.8 | 1.4 | 2.9 | 8.7 | 8.1 | 5.0 |
| | S | 20.0 | 2.2 | 0.4 | 0.8 | 10.2 | 7.3 | 4.3 |
| 5-7 | N | 17.3 | 5.0 | 3.5 | 2.4 | 5.9 | 7.5 | 3.9 |
| | S | 11.5 | 4.7 | 2.0 | 1.6 | 8.9 | 4.6 | 2.2 |
| 11-13 | N | 13.6 | 7.4 | 2.6 | 2.8 | 2.7 | 6.8 | 2.8 |
| | S | 9.3 | 5.6 | 2.5 | 1.8 | 7.5 | 4.4 | 2.3 |

Ceanothus prostratus Study

A study to determine the feasibility of establishing Ceanothus prostratus for soil stabilization purposes was intiated in 1965 by the WMR project at Reno, Nevada. The tests were to be made in four widely separated areas within the Intermountain Region, including the Zena Creek Logging Sale area. In the latter area, 100 cuttings were planted on each of three sites. The survival percentages on these sites, after one season, were reported in a study progress report as follows:

| ZCLS Sites | Survival Percentage |
|---|---|
| Decomposed granite, road fill slope | 83 |
| Unlogged, sandy loam | 40 |
| Logged, sandy loam | 23 |

The high survival on the decomposed granite road fill slopes is most encouraging.

Road Damage Survey

A study plan was prepared in the spring of 1965 as a basis for initiating a survey of road damages. The purpose of the survey was to examine damages on roads constructed during the years 1961-64 on selected areas within the Payette and Boise National Forests. Data were to be collected which would provide for correlating the severity and type of road damage with the following factors:

1. Location, including: (a) road configuration, (b) distance from culvert, and (c) road exposure.

2. Construction, including: (a) road design, (b) culvert installation, (c) type of culvert, and (d) vegetal cover.

3. Year of construction.

This survey was not undertaken by the Station. However, much significant information on road damages and the factors contributing to them was obtained from a survey and hydrologic analysis by Jensen and Finn of the Payette National Forest (18).

Forest Utilization Research

In 1960, E. S. Kotok assumed responsibility for establishing liaison with logging equipment manufacturers, and for conducting a time and cost study of the cable logging system used in the Zena Creek Logging Sale area.

Kotok discussed logging equipment with several manufacturers and operators, but made no formal report concerning the contacts.

Log Production Study

In 1960, a study was prepared by J. L. Faurot under the title: "Plan For the Determination of Logging Production and Cost Data on the Zena Creek Administrative Study."

The stated objective of this plan was:

> To furnish detailed production and cost data for given machines under the varying conditions of operation.

> Other aspects of the Zena Creek study will be coordinated with the time and cost analysis, in an effort to determine the logging system that offers the greatest economic advantage at the lowest damage level to the overall forest values.

Four phases of log production time and cost were to be investigated, including: (1) yarding, (2) loading, (3) truck transportation, and (4) road construction. Yarding production time and cost data were to be obtained on a sample basis by Station personnel. Information concerning the other phases was to be obtained from the logging operator and the Payette National Forest.

Yarding cost data were collected on a sample basis during the summers of 1961 and 1962. Data collected in 1961 were exclusively for the SJ-7 Skagit yarder-loader. In 1962, data were collected for the yarder-loader, with the SJ-7 used only as a yarder, and for the heel boom jammer. Data were collected from a total of 1,261 individual turns, as follows:

> 1961 - 700 turns with Skagit SJ-7 yarder-loader.
> 1962 - 336 turns with Skagit SJ-7 for yarding only.
> 1962 - 225 turns with heel boom jammer.

The data have been analyzed by Marsden to determine differences in log production rates by the two pieces of logging equipment. Marsden and Kotok will collaborate in interpreting the data, and in preparing a Station paper on results. These findings should provide additional useful information on the timber harvesting operations to that obtained from the Administrative Studies previously reported.

Timber Management Research

Timber management research effort on the Zena Creek Logging Study has been limited to seven regeneration planting tests, one of which was carried out on the Boise Basin Experimental Forest. Ponderosa pine 2-0 stock was used in five of the tests; whereas Douglas-fir and Engelmann spruce were used, respectively, in two other tests.

The program was started in 1961, when J. D. Curtis and M. W. Foiles of the Ponderosa Pine Silviculture Project at Boise developed a general study plan, "Regeneration by Planting on Steep Ground, Zena Creek Logging Study, Payette National Forest." The objectives of the proposed study were: (a) to determine the limitations of hand planting slopes too steep (exceeding 40 percent) for planting machines, and (b) to develop techniques of planting that will result in acceptable stocking of group clearcuttings on the sale area.

The general plan was to be implemented by supplemental studies, each with a more specific objective. It was also proposed that TMR personnel would plan the studies, locate the study areas, lay out the study plots, make survival and other technical observations, and report results; and the Payette National Forest would provide materials and personnel for site preparation and planting.

## Soil Stabilization Study

The first specific study under the general plan proposed to include tests of two soil stabilization treatments (straw mulching and no mulching) and three types of site preparation (scalps, pits, and furrows) on two soil types (shallow and deep) and on two aspects (north and south, or east and west). When enough north slope sites could not be found in the fall of 1961, the scope of the study was reduced by limiting the test sites to six blocks of six plots, each on south aspects only.

Plots were located and site preparation work was done in the fall of 1961, and planting was accomplished in the spring of 1962. Seedling survival records were obtained in the fall of 1962, 1963, 1964, 1965, and 1966. Progress on the study was reported each year. Survival percentages and their statistical significance are summarized in Table 2.

## Scalps and Burned Slashpile Spots

A supplemental study was also initiated in 1962 on three shallow soil areas to test the effects of scalped spots, 2-foot, 4-foot, and 6-foot square, and areas of burned slashpiles. A total of 287 spots was planted in May 1962, and survival counts were made in the fall of 1962, 1963, 1964, and 1965. The average seedling survival percentages after four years, as given in the 1966 Progress Report, were as follows:

| Treatments | 1965 Survival (Percent) |
|---|---|
| Scalped, 2-foot square | 49.3 |
| Scalped, 4-foot square | 61.4 |
| Scalped, 6-foot square | 50.8 |
| Burned slash pile spots | 66.3 |

These differences in survival could have occurred by chance.

## Mulch--Aspect Study

In 1963, a third study was initiated to test the effectiveness of three mulching methods (fiberglass, polyethylene, and none) on two aspects (east and west) having deep soil. Plantings were made in the spring of 1963, and survival counts were made that fall, in 1964, 1965, and 1966. Results of this test through 1966 are shown in Table 3. As indicated in the footnotes, the only real difference in survival by 1965 was due to mulching.

## Seed Inhibitor Study

In 1964, a fourth study was initiated to test the effect of simazine, a chemical that tends to inhibit germination of seed in the soil, as well as the effects of three mulches (check, polyethylene, and fiberglass) on two aspects (east and west) and one (deep) soil type. Table 4 gives the survival percentages through 1966, and the statistical significance of 1964 and 1965 survival percentages.

## Weeding--Mulch Study

In 1964, a fifth study was undertaken at the Boise Basin Experimental Forest. This study was designed to test the effects of weeding as well as fiberglass and polyethylene mulches and no mulches on one (west) aspect and one (deep) soil type on: (a) seedling survival, (b) soil moisture, and (c) soil and air temperatures. The test was made at the BBEF to facilitate obtaining the moisture and temperature records.

Table 2. Survival of 2-0 ponderosa pine planted in six different ways on two soil depths, Payette National Forest, 1962

| Treatment | Soil 2 (8" - 16") | | | | | | | | | | Soil 8 (20" - 40") | | | | | | | | | | Average | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mulched | | | | | Unmulched | | | | | Mulched | | | | | Unmulched | | | | | | | | | |
| | 1962 | 63 | 64 | 65 | 66 | 1962 | 63 | 64 | 65 | 66 | 1962 | 63 | 64 | 65 | 66 | 1962 | 63 | 64 | 65 | 66 | 1962 | 63 | 64 | 65 | 66 |
| | Percent | | | | | | | | | | | | | | | | | | | | | | | | |
| Scalps | 69 | 57 | 52 | 48 | 23 | 62 | 51 | 46 | 45 | 36 | 78 | 69 | 49 | 42 | 38 | 59 | 47 | 38 | 34 | 30 | 67 | 57 | 46 | 42 | 32 |
| Pits | 57 | 44 | 39 | 32 | 27 | 64 | 52 | 45 | 36 | 25 | 70 | 57 | 55 | 51 | 37 | 61 | 52 | 36 | 23 | 16 | 63 | 51 | 44 | 35 | 26 |
| Furrows | 59 | 43 | 30 | 21 | 21 | 77 | 67 | 56 | 45 | 20 | 77 | 69 | 53 | 43 | 35 | 64 | 47 | 32 | 24 | 20 | 69 | 57 | 43 | 33 | 24 |
| Average | 61 | 48 | 41 | 34 | 24 | 68 | 57 | 49 | 42 | 27 | 75 | 65 | 52 | 45 | 37 | 61 | 49 | 35 | 27 | 22 | 67 | 55 | 44 | 37 | 27 |

| Experiment ingredients: | | | |
|---|---|---|---|
| Total | 900 trees | 1962 - Soil stabilization | - Significant at 5-percent level |
| Each soil | 450 trees | SS X soil interaction | - Significant at 1-percent level |
| M and UM | 225 trees | 1962 - Blocks | - Significant at 5-percent level |
| Three blocks | 75 trees | 1963 - Blocks | - Significant at 5-percent level |
| Three pl. meth. | 25 trees | 1964 - Blocks | - Significant at 5-percent level |
| | | 1965 - Blocks | - Significant at 1-percent level |

Table 3. Survival on mulched 2-0 ponderosa pine planted on two aspects, on one soil type 8 (20" - 40"), Payette National Forest, 1963.

| Treatment | East | | | | West | | | | Average | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1963 | 1964 | 1965 | 1966 | 1963 | 1964 | 1965 | 1966 | 1963 | 1964 | 1965 | 1966 |
| | Percent | | | | | | | | | | | |
| Check | 63 | 39 | 31 | 20 | 61 | 53 | 47 | 32 | 62 | 46 | 39 | 26 |
| Fiberglass | 76 | 64 | 57 | 48 | 84 | 75 | 67 | 51 | 81 | 69 | 61 | 50 |
| Polyethylene | 35 | 29 | 27 | 22 | 51 | 42 | 37 | 30 | 43 | 36 | 32 | 26 |
| | 58 | 44 | 38 | 30 | 65 | 57 | 50 | 38 | 62 | 50 | 44 | 34 |

Experiment ingredients:

| | | |
|---|---|---|
| Total | 900 trees | 1963 - Mulches significant at 5-percent level |
| Two aspects | 450 trees | 1964 - Aspects significant at 5-percent level |
| Three pl. meth. | 150 trees | 1964 - Mulches significant at 1-percent level |
| Three reps. | 50 trees | 1965 - Mulches significant at 1-percent level |

Table 4. Survival of mulched 2-0 ponderosa pine planted on two aspects, on one soil type 8 (20" - 40"), Zena Creek Payette National Forest, 1964.

| Treatment | East | | | West | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1964 | 1965 | 1966 | 1964 | 1965 | 1966 | 1964 | 1965 | 1966 |
| | -Percent- | | | | | | | | |
| Control | 81 | 73 | 41 | 89 | 85 | 70 | 85 | 79 | 56 |
| Simazine | 86 | 77 | 53 | 94 | 90 | 71 | 90 | 84 | 62 |
| Fiberglass | 83 | 74 | 52 | 92 | 86 | 74 | 87 | 80 | 63 |
| Polyethylene | 89 | 82 | 63 | 93 | 88 | 75 | 91 | 85 | 69 |
| | 85 | 77 | 52 | 92 | 87 | 73 | 88 | 82 | 63 |

Experiment ingredients:

| | |
|---|---|
| Total | 1,600 trees |
| Two aspects | 800 trees |
| Four mulches | 200 trees |
| Four reps. | 50 trees |

1964 - Aspects significant at 1-percent level
1965 - Aspects significant at 1-percent level
M X A interaction significant at 1-percent level

The effect of the mulching treatments on soil moisture and on soil and air temperatures during the 1964 season were reported in the 1965 Progress Report. Table 5 shows the percent of seedling survival one and two years after planting.

Douglas-fir Test

In 1964, 100 Douglas-fir 3-0 seedlings were planted on a study plot in the ZCLS area that had been clearcut in the summer of 1963 and prescribed burned that fall. On 50 scalped spots, mulched with polyethylene, 25 trees were planted with a planting bar and 25 with a shovel. Equal numbers were similarly planted on scalped but unmulched spots. Percent survival for the years 1964, 1965, and 1966, is shown in the following tabulations:

Table 5. Percent survival of mulched 2-0 ponderosa pine seedlings planted on southwest aspect, on one soil type, Boise Basin Experimental Forest, Boise National Forest, 1964.

| Treatment | 1964 | 1965 |
|---|---|---|
| Control | 84 | 67 |
| Weeded | 77 | 67 |
| Fiberglass | 93 | 74 |
| Polyethylene | 89 | 71 |
| Average | 86 | 69 |

Experiment ingredients: Total 300 trees
Three blocks 100 trees
Four mulches 25 trees

1964 - No variables significant
1965 - Blocks significant at 1 percent level

1964 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| Mulched | 96 | 100 | 98 |
| Unmulched | 88 | 96 | 92 |
| | 92 | 98 | 95 |

1965 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| Mulched | 92 | 96 | 94 |
| Unmulched | 76 | 80 | 78 |
| | 84 | 88 | 86 |

1966 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| Mulched | 80 | 88 | 84 |
| Unmulched | 76 | 80 | 78 |
| | 78 | 84 | 81 |

Engelmann Spruce Test

In 1964, 100 Engelmann spruce 3-0 seedlings were planted in an area near the Douglas-fir test area to determine the effect of bar and shovel planting on survival of two groups of seedlings. Groups (a) seedlings had tops 2 to 4 inches long and root lengths of 8 inches or less. Group (b) seedlings were to have tops over 4 inches long and roots over 8 inches long. Only 14 seedlings were available that met the (b) criteria. Therefore, 36 seedlings were used having tops less than 4 inches but with roots over 8 inches. Percent survival of the two groups of seedlings in 1964, 1965, and 1966 is shown in the following tabulations:

1964 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| A Seedlings | 32 | 36 | 34 |
| B Seedlings | 44 | 44 | 44 |
| | 38 | 40 | 39 |

1965 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| A Seedlings | 24 | 32 | 28 |
| B Seedlings | 28 | 44 | 36 |
| | 26 | 38 | 32 |

1966 Percent Survival

| | Bar planted | Shovel planted | Average |
|---|---|---|---|
| A Seedlings | 16 | 20 | 18 |
| B Seedlings | 24 | 32 | 28 |
| | 20 | 26 | 23 |

A Seedlings - Less than 4" top and 8" roots
B Seedlings - Long roots, variable tops

These tests were a well-planned effort to find an effective method of planting in granitic soil on slopes that are too steep for machine perparation. Among the several tests, the most encouraging results were obtained by planting Douglas-fir in the deeper soils of the upper basin where the site had been prepared by broadcast burning. There, first-year survival averaged 95 percent and third-year survival averaged 81 percent.

Results of the ponderosa pine planting tests, by comparison, were less encouraging. First-year survival was substantially lower and this was followed by about a 10-percent mortality each year. The poor survival indicates that unless more effective methods can be developed, pine planting should not be attempted in granitic soils on slopes too steep for machine preparation.

Forest Engineering Research

On October 1, 1961, H. M. Huckeby transferred to the Station as leader of a new Forest Engineering Research Project. He continued to serve on the Zena Creek Logging Study committee. He participated with Usher and other members of the Model Mile subcommittee in developing the design and cost estimates for a proposed "Model Mile" road in the study area, as reported more fully under Administrative Studies.

Following Huckeby's retirement on December 30, 1964, Rulon B. Gardner became leader of the Forest Engineering Systems Research Project, and the Station's representative for Forest Engineering Research on the ZCLS committee and the Model Mile subcommittee.

In 1965, Gardner proposed a study of road and site physical characteristics associated with road failures in the ZCLS area. The study would involve examination and collection of data on several physcial characteristics of the road and site materials at seven locations where failures occurred, and at three locations where failure did not occur. The study is intended to be carried out in cooperation with the Engineering Department of Montana State University. As of the end of F.Y. 1965, the study plan had not been approved.

## EVALUATION SUMMARY

The Zena Creek Logging Study was a major effort on the part of the Forest Service to develop a satisfactory system for harvesting timber on the steeper slopes of the Idaho Batholith. This was a well chosen effort because a large volume of high value timber is available on those lands if economical ways could be found to harvest it and obtain adequate regeneration without causing serious watershed damage. The study also was probably the most complex and difficult task thus far undertaken cooperatively by Administration and Research in the Intermountain Region.

Numerous factors contributed to the complexity and difficultness of the study, some of the most troublesome being:

1. Deeply incised topography with long, very steep slopes between narrow ridges and valleys, which limited road location and use of mechanical equipment.

2. A generally shallow, coarse soil derived from decomposed granite, which was easily disturbed and highly erosive.

3. Severe climatic conditions including sporadic heavy rains and snow melts that produced saturated, unstable mantle conditions, as well as excessive runoff.

4. Timber sale provisions that permitted the purchaser to limit his harvesting operations to those he considered to be profitable and to refuse to carry out some operations that were needed for study purposes.

Notwithstanding these difficulties and some disappointing failures, many valuable lessons were learned from all phases of the study including the planning efforts, the timber sale operations, and the administrative and research studies.

Much planning went into the beginning phases of the study. Selection of the overall problem was certainly well justified. Recognition of the need for some type of mobile spar and/or aerial crane logging system that would require fewer roads and cause less soil disturbance and other resource damage was also a good planning step. However, too little effort was spent on the analysis of requirements for suitable logging equipment and an adequate road system. Also, though much attention was given to operational plans, most of the timber harvesting and other administrative studies went forward without the benefit of properly designed tests or prior coordination with Research.

These initial planning deficiencies led to some failures and questionable results during the early years of the study. However, as the study progressed, both good and bad practices were alertly recognized and plans were altered to avoid repetition of mistakes and to incorporate promising features.

The originally planned timber sale operation called for constructing 75 miles of logging road and the harvesting of 60 MMBF of timber. Most of the timber was to be clearcut and logging was to be accomplished in some compartments by means of a mobile spar and aerial crane, and on others by jammer and tractor.

Serious problems developed in the first few years of the timber sale operations. Numerous sections of the partially constructed road system failed, causing severe watershed damage. The Skagit SJ-7R combination mobile spar and grapple loader and the sky car frequently broke down and, at best, could yard logs for distances of only about 800 feet, resulting in much less log production than anticipated. Recruises revealed less timber volume on parts of the sale area than was originally estimated. It also became obvious that the Tailholt and Circle End watersheds should not be roaded or logged until adequate pretreatment streamflow records could be obtained.

Some of these problems were resolved by amending the timber sale contract in 1963. The amendments provided for eliminating the Tailholt and Circle End drainages from the sale area for calibration purposes, and some low volume stands on sites that would be uneconomical and hazardous to reach. Elimination of these areas reduced the sale volume to 40 MMBF, but it also greatly reduced the mileage of required roads and the attendant risk of further watershed damage.

The timber sale operations during the last years of the study progressed with increased speed and efficiency. An improved Skagit mobile spar was added to the logging equipment and operating difficulties with the sky car were reduced. The improved equipment permitted yarding over distances up to 1800 feet and a wider spacing of roads. The greatest efficiency was achieved by using jammers and tractors to log along roads and on gently sloping areas and by using the mobile spar and sky car for yarding logs from more distant slopes. Under this combination, log production of 50 MBF per day was achieved.

However, even this combination does not appear to be a fully satisfactory solution for the steeper portions of the Idaho Batholith. The solution appears to lie in a system that will provide for aerial logging over substantially greater slope distances, with much fewer roads and no roads at all on the vulnerable areas.

The Administrative Studies program produced several kinds of additional information beyond that learned from the timber sale operations. Useful records were obtained on stump-to-truck costs of logging by the mobile spar and sky car system, as well as by jammer and tractor. Improved techniques were developed for brush disposal, and specific methods of preparing sites for regeneration planting were determined for several different site conditions. Some improvements were made in road stabilization methods including procedures for putting roads to bed. New information was obtained on big game grazing habits and on big game habitat which indicated big game requirements and timber harvesting operations to be compatible, with the possible exception of the sparsely timbered riverbreak lands.

Probably the most important information concerning the steeply sloping granitic lands was derived from the initial soil survey, the flood damage surveys, and the final condition survey. The latter, particularly, revealed there are several distinct land forms within the study area which have greatly different hydrologic and erosion resistant capacities. Had these differences been more fully understood during the planning stages of the study, much watershed damage could have been prevented. However, this new, critically important information can be of great usefulness in planning and carrying out future timber harvesting and other uses on other portions of the Idaho Batholith.

The supplementary Research Studies also produced some new and urgently needed information. The climatic and streamflow records were the first to be obtained in that portion of the Batholith. The new precipitation records, when combined with existing data, provided a sound basis for predicting storm events, and the streamflow records provided detailed information on runoff and sediment production characteristics. Continuation of these records for a few more years should provide a sound basis for evaluating the effects of logging on both runoff and sediment production.

Attempts to find effective methods of planting were encouraging as far as the upper elevation and deeper soil sites were concerned. They were less encouraging on the drier, shallower soil, that are too steep for machine site preparation and planting. Unless more effective methods can be developed for the latter sites, it appears that they should be excluded from timber harvest.

A forthcoming report should provide detailed information on cost-time relations of yarding and loading by the systems used in the study.

No engineering research was carried out on the road system but much was learned about poor location, design, construction, maintenance, and supervision from trial and error experience during the course of the study which should be of great value in planning other roads in the Batholith area.

The Zena Creek Logging Study as a whole accomplished much toward a better understanding of the timber management possibilities on the steeply sloping lands of the Idaho Batholith. The study demonstrated that timber can be harvested economically and without watershed damage on portions of the steeper lands by careful location and construction of logging roads and use of a mobile spar and aerial crane. It also demonstrated that some of the lands having shallow soil derived from decomposed granite are too unstable to withstand the disturbance of road construction. Therefore, unless some aerial cable system can be devised that will permit yarding logs at greater distances and without having to build roads across vulnerable slopes, it appears that some portion of the Batholith should not be managed for timber production.

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